

**Prepared in cooperation with Virginia Department of Health** 

Water-Quality Data from Ground- and Surface-Water Sites near Concentrated Animal Feeding Operations (CAFOs) and non-CAFOs in the Shenandoah Valley and Eastern Shore of Virginia, January—February, 2004

Open-File Report 2005-1388



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By Karen C. Rice,<sup>1</sup> Michele M. Monti,<sup>2</sup> and Matthew R. Ettinger<sup>3</sup>

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<sup>&</sup>lt;sup>1</sup>U.S. Geological Survey

<sup>&</sup>lt;sup>2</sup>Virginia Department of Health

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# **Conversion Factors and Abbreviated Water-Quality Units**

Multiply	Ву	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m <sup>2</sup> )
acre	0.4047	hectare (ha)
square mile (mi²)	259.0	hectare (ha)
square mile (mi²)	2.590	square kilometer (km²)
	Volume	
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m³)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

Vertical coordinate information is referenced to the North Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Abbreviated water-quality units: Chemical concentration is reported in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million. Specific electrical conductance of water is reported in microsiemens per centimeter at 25 degrees Celsius (µS/cm).

# Water-Quality Data from Ground- and Surface-Water Sites near Concentrated Animal Feeding Operations (CAFOs) and non-CAFOs in the Shenandoah Valley and Eastern Shore of Virginia, January—February, 2004

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### **Abstract**

Concentrated animal feeding operations (CAFOs) result from the consolidation of small farms with animals into larger operations, leading to a higher density of animals per unit of land on CAFOs than on small farms. The density of animals and subsequent concentration of animal wastes potentially can cause contamination of nearby ground and surface waters. This report summarizes water-quality data collected from agricultural sites in the Shenandoah Valley and Eastern Shore of Virginia. Five sites, three non-CAFO and two dairy-operation CAFO sites, were sampled in the Shenandoah Valley. Four sites, one non-CAFO and three poultry-operation CAFO sites were sampled on the Eastern Shore. All samples were collected during January and February 2004.

Water samples were analyzed for the following parameters and constituents: temperature, specific conductance, pH, and dissolved oxygen; concentrations of the indicator organisms *Escherichia coli* (*E. coli*) and enterococci; bacterial isolates of *E. coli*, enterococci, *Salmonella* spp., and *Campylobacter* spp.; sensitivity to antibiotics of *E. coli*, enterococci, and *Salmonella* spp.; arsenic, cadmium, chromium<sup>3+</sup>, copper, nickel, and mercury; hardness, biological oxygen demand, nitrate, nitrite, ammonia, ortho-phosphate, total Kjeldahl nitrogen, chemical oxygen demand, total organic carbon, and dissolved organic carbon; and 45 dissolved organic compounds, which included a suite of antibiotic compounds.

Data are presented in tables 5-21 and results of analyses of replicate samples are presented in tables 22-28. A summary of the data in tables 5-8 and 18-21 is included in the report.

## Introduction

Over the last two decades, the consolidation of small farms with animals into larger operations has resulted in the creation of concentrated animal feeding operations (CAFOs). The U.S. Environmental Protection Agency (USEPA) defines CAFOs as "point sources that require National Pollutant Discharge Elimination System (NPDES) permits for discharges or potential discharges. Once an operation is defined as a CAFO, the NPDES requirements for CAFOs apply with respect to all animals in confinement at the operation and all manure, litter, and process wastewater generated by those animals or the production of those animals, regardless of the type of animal." CAFOs are "animal feeding operations in which animals (other than aquatic animals) have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility" (U.S. Environmental Protection Agency, 2004). The number of animals (for example, more than 200 dairy cows, 300 beef cattle, 20,000 chickens, and so on) also determines whether the operation is a CAFO; CAFOs were once defined by "animal units" but under the CAFO Final Rule, the USEPA instead sets CAFO thresholds by determining the actual number of animals. Animal feeding operations below CAFO thresholds can be required to adhere to CAFO permitting requirements if the operation is adjacent to navigable waters and discharges directly or indirectly into those waters.

The proliferation of CAFOs has raised concerns about air pollution and ground- and surface-water pollution, including the risk of contamination of waters by microbial pathogens found in animal waste. The concentration of animals has resulted in a concentration of wastes that has been estimated at 1.6 billion tons per year (Cole and others, 1999). Other public health and ecological concerns related to CAFOs include

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nutrient overload of waterways leading to algal blooms and resulting low dissolved oxygen concentrations, the possible increase in organisms such as Pfiesteria piscicida and Pfiesteria shumwayae that can cause fish kills, an increase in antibiotic-resistant organisms from the broad application of antimicrobials to farm animals, and questions about the quality of life in communities adjacent to CAFOs.

Research into human-health risks related to CAFOs has initially focused on occupational hazards for workers in these operations, such as gases, dust particulates, and endotoxins (Donham, 1990; Zuskin and others, 1991; Donham and others, 1995; Von Essen and Donham, 1999). More recently, psychological and physiological impacts on residents of nearby communities have been described (Wing and Wolf, 2000; Schiffman and others, 1995; Thu and others, 1997), as well as social and economic issues such as environmental justice and quality of life in these communities (Wing and others, 2000).

A concern for both human and ecological health is the chemical and microbiological contamination of ground and surface waters by runoff from land application of manure or from waste storage and treatment. Elevated concentrations of nutrients, metals, bacteria, and a number of other chemicals and pathogens are observed in ground and surface waters in many agricultural areas throughout the United States. Excess nutrients may be an important contributing factor for the growth and increase in dinoflagellates such as *Pfiesteria*. Many of the infectious organisms that cause illness in animals also can cause disease in humans and can survive in water. Among the most common pathogens that pose a human-health risk include Salmonella spp., Escherichia coli O157:H7 (E. coli), Campylobacter spp., Listeria monocytogenes, as well as viruses and protozoa such as Cryptosporidium parvum and Giardia. These organisms have been found in ground water in a number of communities.

Hog, dairy and beef cattle, and poultry operations are located throughout Virginia. Although the bulk of the poultry industry is concentrated in the northwestern part of the State, many of these operations also are in eastern counties. The Virginia Department of Health (VDH) is interested in the potential impact of these animal industries on the health of communities and waterways in the State. To investigate this potential impact, the U.S. Geological Survey (USGS), in cooperation with VDH, collected water-quality data from sites in the Shenandoah Valley and Eastern Shore of Virginia.

# **Purpose and Scope**

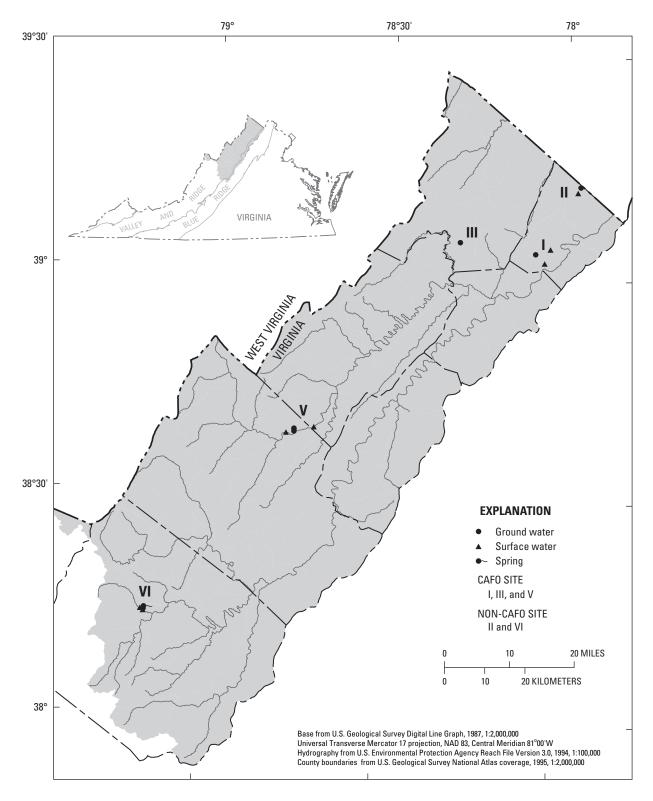
This report describes the results of field and laboratory analyses of ground- and surface-water samples collected within 1.5 miles of CAFO and non-CAFO sites. The samples were collected in the Shenandoah Valley and the Eastern Shore of Virginia during January and February 2004.

### Site Selection and Numbering

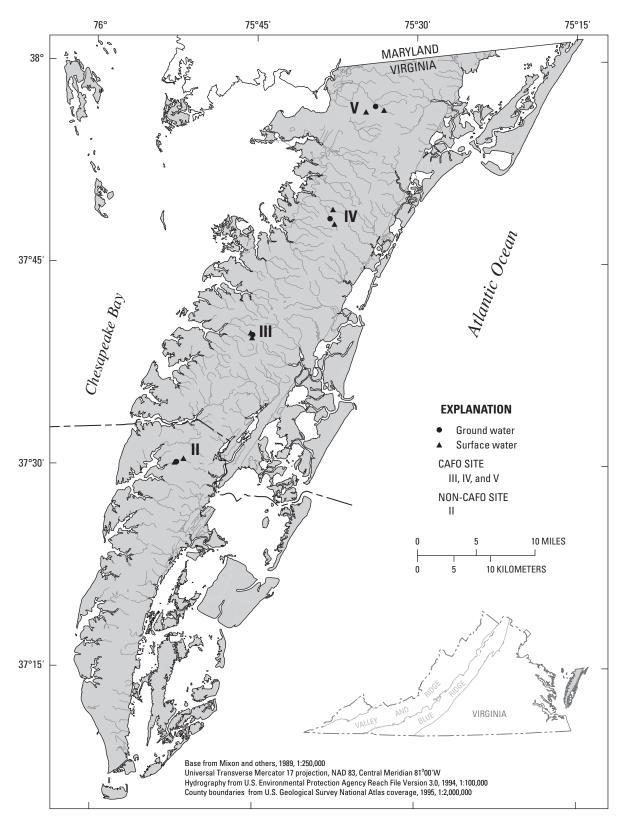
VDH began this project in 2001 with methods investigation and sampling site selection. VDH personnel searched permit files of the Virginia Department of Environmental Quality (DEQ) and nutrient management files of the Virginia Department of Conservation and Recreation (DCR) to identify all CAFOs in the State along with ambient water-quality monitoring data for bodies of water potentially impacted by these operations. A CAFO in the DEQ and DCR databases was defined on the basis of the USEPA's definition of hog, cattle, and poultry operations (U.S. Environmental Protection Agency, 2004). From these databases, VDH personnel selected three sites in the Shenandoah Valley and four sites on the Eastern Shore that were within 1.5 miles of CAFOs for the collection of samples of ground and surface waters. For comparison, three sites in the Shenandoah Valley and two sites on the Eastern Shore that were non-CAFO agricultural sites were selected using information from the Natural Resource Conservation Service, DEQ, and DCR files for ground- and surface-water sampling. All sites selected in the Shenandoah Valley were dairy operations. On the Eastern Shore, CAFO poultry operations were compared with non-CAFO sheep farms because non-CAFO poultry operations do not exist (figs. 1-2).

The numbering system for the sampling sites was as follows: sites were given a Roman numeral, starting with I for the first site selected; water samples collected were further designated with "GW" for ground water; "spring" for spring water; "A" for surface water collected upstream of the agricultural site; and "B" for surface water collected downstream of the agricultural site. Sites IV and V on the Eastern Shore, however, were mistakenly mislabeled from the onset, so that A and B were reversed; this mislabeling was retained to avoid confusion. One site had more than one well; in this case, the site identification for each well that was sampled included a descriptor such as "new" or "house," indicating the approximate location of the well at the site. All wells sampled were for agricultural supply or residential use.

Five sites were sampled in the Shenandoah Valley (fig. 1); sites II and VI are non-CAFO sites and sites I, III, and V are dairy-operation CAFO sites. A site IV was identified during initial site selection, but the site was dropped because of drought conditions and a lack of surface-water sampling locations. Of the four sites sampled on the Eastern Shore (fig. 2), site II is a non-CAFO site, and sites III, IV, and V are poultry-operation CAFO sites. Two sites (I and VI) on the Eastern Shore were identified during initial site selection; however, permission to sample the wells and surface water at the sites was not obtained from the landowners. Animal densities at all of the sampling sites are summarized in Table 1.



**Figure 1.** Locations of concentrated animal feeding operations (CAFO) and non-CAFO sites sampled in Shenandoah Valley, Va.



**Figure 2.** Locations of concentrated animal feeding operations (CAFO) and non-CAFO sites sampled on Eastern Shore, Va.

Table 1. Animal densities at sampling sites.

[CAFO, concentrated animal feeding operation]

CAFO Sites	Non-CAFO Sites						
Shenandoah Valley							
I: 1650 dairy cows	II: 155 dairy cows						
III: 240 dairy cows	VI 250 C 11: 11 C						
V: 410 dairy cows	VI: 350 non-confined dairy and beef cows						
	Eastern Shore						
III: 125,000 broiler chickens							
IV: 66,000 broiler chickens	II: fewer than 100 sheep						
V: 60,000 broiler chickens							

# **Collection and Analysis of Samples**

Water samples were analyzed for field water-quality parameters and in the laboratory for concentrations of the indicator organisms E. coli and enterococci. Bacterial isolates (a colony-forming unit) of E. coli, enterococci, Salmonella spp., and Campylobacter spp. were identified. Microbiological testing also included sensitivity to antibiotics to determine if resistance of E. coli, enterococci, or Salmonella spp. to antibiotics was present. Metal concentrations analyzed by the laboratory included arsenic, cadmium, chromium<sup>3+</sup>, copper, nickel, and mercury. Nutrient concentrations and other laboratory chemical parameters included hardness, biological oxygen demand (BOD), nitrate (NO<sub>3</sub>), nitrite (NO<sub>2</sub>), ammonia (NH<sub>3</sub><sup>+</sup>), ortho-phosphate (P), total Kjeldahl nitrogen (TKN), chemical oxygen demand (COD), total organic carbon (TOC), and dissolved organic carbon (DOC). In addition, water samples were analyzed by liquid chromatography/mass spectrometry for 45 dissolved organic compounds, which included a suite of antibiotic compounds and degradation products.

#### Field Data-Collection Methods

Surface-water samples were collected as grab samples; ground-water samples were collected directly from the spigot exiting the well; that is, the wells were not purged and the samples were drawn through existing equipment. The water-quality parameters temperature, specific conductance, pH, and dissolved oxygen were measured in the field with a YSI 610-D multiparameter meter. For surface-water samples, the probes were placed directly in the stream. For ground-water samples, the multiparameter meter probes were placed in a YSI flow-through chamber. Once the parameters had stabilized, usually within a couple of minutes, the field parameters were recorded and samples for laboratory analysis were collected.

Samples for microbiological testing of E. coli and enterococci concentrations were collected in a 100-mL screw-cap sterile bottle made of clear polystyrene plastic and preserved with sodium thiosulfate. Two 3.78-L (1-gallon) low-density polyethylene (LDPE) cubitainers were filled with sample water for analysis of the remaining microbiological pathogens (bacterial isolates and sensitivity to antibiotics of E. coli, enterococci, and Salmonella spp.). Samples for analysis of metal concentrations by inductively coupled plasma-mass spectrometry were collected in a 250-mL screw-cap bottle and preserved with 1:1 nitric acid (HNO<sub>3</sub>); hardness was determined from this same sample bottle. Samples for nutrients and other chemical parameters were collected as follows: a 3.78-L cubitainer was filled with sample water for BOD and nutrient analyses; a 250-mL HDPE bottle with sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) as a preservative was filled with sample water for TKN and COD analyses; two 40-mL clear glass vials with sufficient HCl preservative to bring the sample to pH less than 2.0 units were filled with sample water for TOC and DOC analyses.

Samples for analysis of antibiotic residue were collected using USGS protocols for the collection of samples for pesticide analysis (Shelton, 1994). Briefly, all processing equipment was precleaned with a Liquinox/tap-water solution, rinsed with tap water, rinsed with deionized water, rinsed with methanol, and allowed to air dry. Sample water was filtered through a 0.7-micrometer (µm) pore-size baked glass-fiber filter. The filter was rinsed with 100 mL of sample water before the samples were filtered into three 125-mL (4-oz) baked amber glass bottles. All water samples were transported on ice to the laboratories.

### **Laboratory Analysis Methods**

Microbiological, metal, and nutrient samples were analyzed by the Division of Consolidated Laboratory Services (DCLS) of the Virginia Department of General Services, using the methods and detection limits identified in Table 2.

 Table 2.
 Laboratory methods and detection limits for microbiological, metal, and nutrient samples.

[mL, milliliter; L, liter; µg/L, micrograms per liter; ppm, parts per million; mg/L, milligrams per liter; USEPA, U.S. Environmental Protection Agency; USFDA, U.S. Food and Drug Administration]

Parameter	Container size	Method	Reference for method	Detection limit, units
		Microb	piological	
Escherichia coli		SOP#2-121	USEPA Method 1103.1 Membrane Filter Test Method for <i>E. coli</i> in water	_1
Enterococci	100-mL bottle	SOP#2-122	USEPA Method 1600 Membrane Filter Test Method for enterococci in water	_1
Salmonella spp.	3.79-L cubitainer	SOP#2-470	USFDA, 1995, 1998	_2
Campylobacter spp.	3.79-L cubitainer	SOP#2-415	USFDA, 1995	_2
		M	etals	
Arsenic				5 μg/L
Cadmium				5 μg/L
Chromium <sup>3+</sup>				10 μg/L
Copper	250-mL bottle with HNO <sub>3</sub>	USEPA 200.8	USEPA, 1994	10 μg/L
Nickel	with Thivo <sub>3</sub>			10 μg/L
Mercury				0.3 μg/L
Hardness				1.0 ppm
		Nut	trients	
Biological oxygen demand	1.89-L cubitainer	Standard Method 5210-B	Clesceri, Greenberg, and Eaton, 1998	2 mg/L
Nitrate	1.89-L cubitainer	USEPA 353.2	USEPA, 1983	0.04 mg/L
Nitrite	1.89-L cubitainer	USEPA 353.2	USEPA, 1983	0.01 mg/L
Ammonia	1.89-L cubitainer	USEPA 350.1	USEPA, 1983	0.04 mg/L
Ortho-phosphate	1.89-L cubitainer	USEPA 365.3	USEPA, 1983	0.02 ppm
Total Kjeldahl nitrogen	250-mL bottle	USEPA 351.2	USEPA, 1983	0.1 ppm
Chemical oxygen demand	with H <sub>2</sub> SO <sub>4</sub>	ASTM D152-88	USEPA, 1983	5.0 mg/L
Total organic carbon	40-mL vial with HCl	Standard Method 5310-B	Clesceri, Greenberg, and Eaton, 1998	2 mg/L
Dissolved organic carbon	40-mL vial with HCl	Standard Method 5310-B	Clesceri, Greenberg, and Eaton, 1998	2 mg/L

<sup>&</sup>lt;sup>1</sup>No limit for detection of *E. coli* and enterococci.

<sup>&</sup>lt;sup>2</sup>A sample is considered positive when any *Salmonella* spp. or *Campylobacter* spp. are isolated; a sample is considered negative when no *Salmonella* spp. or *Campylobacter* spp. are isolated.

All microbiological techniques are designed to identify any culturable cells present in the sample. Each technique has limitations because of the variability of the distribution of pathogens in any sample. It is impossible to completely homogenize a sample of water. The DCLS used the membrane filtration technique for determining concentrations of *E. coli* and enterococci. For ground-water samples, where pathogen concentrations are expected to be low, 10-mL and 50-mL dilutions of the original sample were made. Of the original 100-mL sample, 10 mL were extracted with a pipette, placed in a filter cup and filtered, plated on growth media, and counted. Likewise, for a 50-mL dilution, 50 mL from the original 100 mL sample were pipetted out, filtered, and analyzed. For surface-water samples, where concentrations are expected to be higher, the dilutions used were 5 mL and 20 mL.

Dissolved organic compounds in water samples were analyzed by the USGS Organic Geochemistry Research Group in Lawrence, Kansas. Detection limits for these compounds are shown in Table 3. Analysis of these compounds indicates the amount of antibiotic residue in the samples.

## **Quality Assurance and Quality Control**

For *E. coli*, the specificity of the medium used in the test is 9 percent false positive for marine and fresh water samples and 1 percent false negative for various environmental water samples. The ratio of false positive was calculated as the percentage of colonies that are not verified. The ratio of false negative was calculated as the percentage of verified colonies that do not react typically. The persistent positive of negative deviation of the result value has been reported to be -2 percent of the true value. The degree of agreement of repeated measurements of the same parameter is expressed quantitatively as the standard deviation or as the 95 percent confidence limits of the mean computed from the results of a series of controlled determinations.

For entercocci, the specificity of the medium used in the test is 6 percent false positive and 6.5 percent false negative for various environmental water samples. The ratio of false positive was calculated as the percentage of colonies that are not verified. The ratio of false negative was calculated as the percentage of verified colonies that do not react typically. The persistent positive or negative deviation of the results value is not significant.

Replicate samples were collected at sites V and VI in the Shenandoah Valley. Replicate samples were collected immediately after the first sample was collected, and the time of collection was set at five minutes after the first sample. The purpose of replicate samples is to evaluate any variability in the sampling and analysis processes.

# **Results and Summary**

Concentrations of all of the dissolved organic compounds shown in Table 3 were below the detection limits at all sites sampled. Results of all of the other parameters analyzed for all samples are shown in Tables 5-21. Results of all replicate samples analyzed are shown in Tables 22-28. For a quick comparison of the ranges of concentrations of most of the parameters analyzed by the DCLS, refer to Table 4.

# **Acknowledgments**

We acknowledge the Centers for Disease Control and Prevention for funding for this project; Ann Munson, Division of Consolidated Laboratory Services Department of General Services, for laboratory oversight; and the following USGS personnel: Steven Schriver and Richard Ahlin, for field sampling assistance; Kenneth Hyer and Stephen Harden, for providing colleague reviews of the report; Martha Erwin for editorial assistance; and Robert Banks and Theodore Samsel for graphics support.

## **References Cited**

- Clesceri, L.S., Greenberg, A.E., and Eaton, A.D., eds., 1998, Standard methods for the examination of water and wastewater (20th ed.): Washington, D.C.: American Public Health Association, American Water Works Association, Water Environment Federation, 1325 p.
- Cole, D., Hill, V.R., Humenik, F.J., and Sobsey, M.D., 1999, Health, safety, and environmental concerns of farm animal waste: Occupational Medicine—State of the Art Reviews, v. 14, no. 2, p. 423-448.
- Donham, K.J., Reynolds, S.J., Whitten, P., Merchant, J.A., Burmeister, L., and Popendorf, W.J., 1995, Respiratory dysfunction in swine production facility workers—Doseresponse relationships of environmental exposures and pulmonary function: American Journal of Industrial Medicine, v. 27, p. 405-418.
- Donham, K.J., 1990, Health effects from work in swine confinement buildings: American Journal of Industrial Medicine, v. 17, p.17-25.
- Schiffman, S.S., Miller, E.A.S., Suggs, M.S., and Graham, B.G., 1995, The effect of environmental odors emanating from commercial swine operations on the mood of nearby residents: Brain Research Bulletin, v. 37, no. 4, p. 369-375.

Shelton, L.R., 1994, Field guide for collecting and processing stream-water samples for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 94-455, 50 p. Also available on-line at URL: http://

ca.water.usgs.gov/pnsp/pest.rep/sw-t.html

- Thu, K., Donham, K., Ziegenhorn, R., Reynolds, S., Thorne, P.S., Subramanian, P., Whitten, P., and Stokesberry, J., 1997, A control study of the physical and mental health of residents living near a large-scale swine operation: Journal of Agricultural Safety and Health, v. 3, no. 1, p. 13-26.
- U.S. Environmental Protection Agency (USEPA), 1983, Methods for chemical analysis of water and wastes: Office of Research and Development, Washington, D.C. (EPA/600/4-79/020), 552 p.
- U.S. Environmental Protection Agency (USEPA), 1994, Methods for determination of metals in environmental samples,
   Method 200.8: U.S. EPA National Exposure Research
   Laboratory, Supplement 1 (EPA/600/R-94/111), 260 p.
- U.S. Environmental Protection Agency (USEPA), 2004, Permit application and special NPDES Program requirements, subpart B of part 122 of EPA Administered permit programs: The national pollutant discharge elimination system: Code of Federal Regulations, Title 40, Part 122, p. 167-172. (Revised July 1, 2004.)
- U.S. Food and Drug Administration (USFDA), 1995, Bacteriological analytical manual (8th ed.): AOAC International, 28 chapters, 3 appendixes.
- U.S. Food and Drug Administration (USFDA), 1998, Bacteriological analytical manual (8th ed.) revision A: AOAC International, 28 chapters, 3 appendixes.
- Von Essen, S., and Donham, K., 1999, Illness and injury in animal confinement workers: Occupational Medicine—State of the Art Reviews, v. 14, no. 2, p. 337-351.
- Wing, S., and Wolf, S., 2000, Intensive livestock operations, health, and quality of life among Eastern North Carolina residents: Environmental Health Perspectives, v. 108, no. 3, p. 233-238.
- Wing, S., Cole, D., and Grant, G., 2000, Environmental injustice in North Carolina's hog industry: Environmental Health Perspectives, v. 108, no. 3, p. 225-231.
- Zuskin, E., Kanceljak, B., Schacter, E.N., Mustajbegovic, J., Goswami, S., Maayani, S., Marom, Z., and Rienzi, N., 1991, Immunological and respiratory findings in swine farmers: Environment Research, v. 56, p. 120-130.

**Table 3** Laboratory method detection limits in micrograms per liter ( $\mu g/L$ ) for dissolved organic compounds.

[\* indicates a degradation product]

Beta Lactams	Macrolides			
Amoxicillin	0.20	Erythromycin	0.10	
Ampicillin	0.10	*Anhydro-erythromycin	0.05	
Cefotaxime	0.10	Lincomycin	0.05	
Cloxacillin	0.10	Ormetoprim	0.05	
Oxacillin	0.10	Roxithromycin	0.10	
Penicillin G	0.10	Trimethoprim	0.05	
Penicillin V	0.10	Tylosin	0.10	
		Virginiamycin	0.10	
Quinolines		Sulfonamide	s	
Ciprofloxacin	0.05	Sulfachloropyridazine	0.05	
Clinafloxacin	0.05	Sulfadiazine	0.05	
Flumequine	0.05	Sulfadimethoxine	0.05	
Lomefloxacin	0.05	Sulfamerazine	0.05	
Norfloxacin	0.05	Sulfamethazine	0.05	
Ofloxacin	0.05	Sulfamethoxazole	0.05	
Oxolinic Acid	0.05	Sulfathiazole	0.05	
Sarafloxacin	0.05			
Tetracyclines				
Chlorotetracycline	0.10			
*Anhydro-chlorotetracycline	0.10			
*Epi-anhydro-chlorotetracycline	0.10			
*Epi-chlorotetracycline	0.10			
*Iso-chlorotetracycline	0.10			
*Iso-epi-chlorotetracycline	0.10			
Demeclocycline	0.10			
Doxycycline	0.10			
Minocycline	0.20			
Oxytetracycline	0.10			
*Epi-oxytetracycline	0.10			
Tetracycline	0.10			
*Anhydro-tetracycline	0.20			
*Epi-anhydro-tetracycline	0.10			
*Epi-tetracycline	0.10			

Table 4. Summary of data in tables 5-8 and 18-21.

[Range of values for each parameter are given; when the value is listed as less than (<), all reported values were less than that value; GW, ground water; SW, surface water;  $^{\circ}$ C, degrees Celsius;  $\mu$ S/cm, microsiemens per centimeter; mg/L, milligrams per liter; mL, milliliter;  $\mu$ g/L, micrograms per liter; ppm, parts per million]

	Shenan	doah Valley	Easte	Eastern Shore		
Parameter, unit	Non-CAFO sites	CAFO sites	Non-CAFO sites	CAFO sites		
Water temperature, °C	4.1-12	2.3-11	3.3-15	0.11-15		
Specific conductance, µS/cm	108-989	298-789	167-241	159-1000		
Dissolved oxygen, mg/L	2.9-14	0.44-15	2.1-10	0.39-12		
pH, units	6.38-7.82	6.87-8.17	5.91-9.09	6.19-9.56		
Escherichia coli/100 mL, GW, 10-mL dilution	<10-10	<10	<10	<10		
Enterococci/100 mL, GW, 10-mL dilution	<10	<10-50	<10	<10		
Escherichia coli/100 mL, SW, 5-mL dilution	<20-80	60-120	20-40	<20-160		
Enterococci/100 mL, SW, 5-mL dilution	<20-120	20-60	20-80	<20-80		
Arsenic, μg/L	<5	<5	<5	<5		
Cadmium, µg/L	<5	<5	<5	<5		
Chromium³+, μg/L	<10	<10	<10	<10		
Copper, μg/L	<10-14	11-47	<10	<10-99		
Nickel, μg/L	<10	<10	<10	<10		
Mercury, μg/L	< 0.3	<0.3-0.8	< 0.3	< 0.3		
Hardness, ppm	49-519	6-371	42-95	33-96		
Biological oxygen demand, mg/L	<2-2	<2	<2	<2-2		
Nitrate, mg/L	0.56-13	2.5-15	< 0.04-2	<0.04-8		
Nitrite, mg/L	< 0.01-0.05	<0.01-0.26	< 0.01	< 0.01		
Ammonia, ppm	< 0.04	<0.04-0.12	<0.04-0.12	<0.04-0.58		
Ortho-phosphate, ppm	< 0.02	<0.02-0.02	< 0.02	<0.02-0.11		
Total Kjeldahl nitrogen, ppm	<0.1-0.3	<0.1-0.3	0.1-0.5	0.2-1.4		
Chemical oxygen demand, mg/L	<5	<5	<5-14	<5-28		
Total organic carbon, mg/L	<2	<2	<2-5	<2-11		
Dissolved organic carbon, mg/L	<2	<2	<2-5	<2-11		

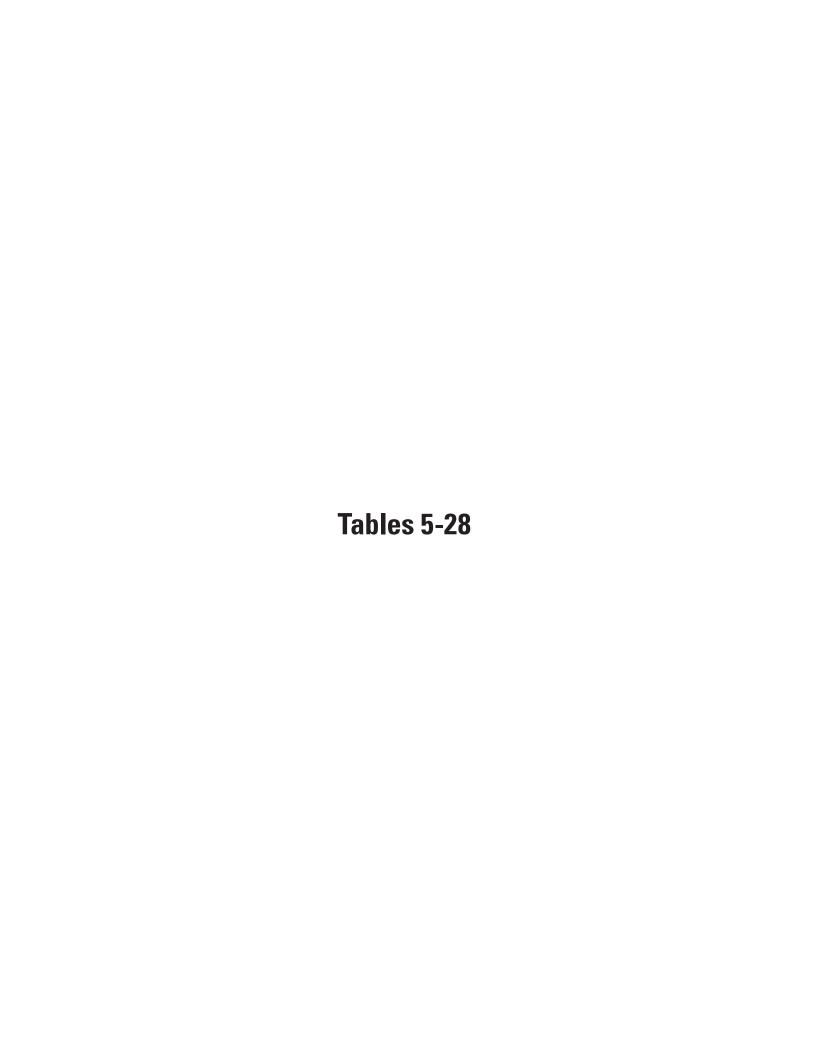


Table 5. Field parameters of samples collected from Shenandoah Valley, Va.

[Roman numeral refers to site location on Figure 1; GW, ground water;  $^{\circ}$ C, degrees Celsius;  $\mu$ S/cm, microsiemens per centimeter at 25  $^{\circ}$ C; mg/L, milligrams per liter; time is in military time units, Eastern Standard Time]

Site	Water Date Time temperature,		Specific conductance, -	Dissolved	pН,		
Sile	Date	IIIIle	temperature, ° C	μS/cm	mg/L	mg/L %	
I-A	01/13/04	0900	6.84	544	11.61	95.5	8.17
I-B	01/13/04	0915	4.78	494	11.97	93.4	8.01
I-GW	01/13/04	1030	10.75	649	4.59	41.5	7.19
II-GW	01/12/04	1515	12.35	833	6.99	65.6	7.03
II-B	01/12/04	1545	6.72	521	12.16	99.6	7.82
III-GW	01/13/04	1345	9.12	553	7.09	61.6	7.26
V-GW-new	02/19/04	1102	2.33	658	10.82	79.3	7.52
V-GW-house	02/19/04	1202	7.58	683	0.44	3.0	7.23
V-GW-silo	02/19/04	1134	7.08	789	3.98	33.0	6.87
V-A	02/19/04	1228	4.76	331	14.48	112.8	8.16
V-B	02/19/04	1258	4.88	298	14.56	113.7	8.01
VI-GW	02/17/04	1142	10.40	989	2.89	25.9	6.38
VI-spring	02/17/04	1223	10.97	502	10.02	90.9	6.83
VI-A	02/17/04	1353	4.35	108	13.71	105.9	7.03
VI-B	02/17/04	1312	4.14	126	14.22	109.0	6.96

 Table 6.
 Field parameters of samples collected from Eastern Shore, Va.

[Roman numeral refers to site location on Figure 2; GW, ground water;  $^{\circ}$ C, degrees Celsius;  $\mu$ S/cm, microsiemens per centimeter at 25  $^{\circ}$ C; mg/L, milligrams per liter; time is in military time units, Eastern Standard Time]

Site	Water te Date Time temperatu		Water temperature,	Specific conductance, -	Dissolved	pH,	
Site	Date	IIIIIG	° C	μS/cm	mg/L	%	units
II-A	01/20/04	1045	3.25	167	9.07	67.8	5.91
II-GW	01/20/04	1115	15.18	241	2.08	20.8	9.09
II-B	01/20/04	1145	4.17	189	10.07	77.2	7.27
III-GW	01/20/04	1445	12.10	214	0.39	3.7	9.56
III-A	01/20/04	1530	4.40	161	10.70	82.5	8.01
III-B	01/20/04	1600	3.84	212	11.97	91.0	7.73
IV-B	01/21/04	0815	2.72	183	8.28	61.1	6.87
IV-A	01/21/04	0845	0.11	159	10.48	71.6	6.91
IV-GW	01/21/04	0915	11.05	229	2.13	21.0	8.85
V-A	01/21/04	1115	1.24	168	8.66	61.3	6.89
V-B	01/21/04	1145	0.22	179	7.00	48.2	6.19
V-GW	01/21/04	1230	15.02	1,000	5.04	50.2	8.94

**Table 7.** Microbiological results for ground-water samples collected from Shenandoah Valley and Eastern Shore, Va.

[Virginia instantaneous water-quality standard for *E. coli* is 235 colony-forming units per 100 milliliters (units/100 mL); for enteroccoci, the standard is 61 colony-forming units/100 mL (9 VAC 25-260-170)]

Commis			E. Col	<i>i</i> /100 mL	Enteroccoci/100 mL				
Sample identification	Date	Time	10-mL 50-mL dilution		10-mL dilution	50-mL dilution			
Shenandoah Valley									
II-GW	1/12/04	1515	<10	<2	<10	<2			
I-GW	1/13/04	1030	<10	<2	<10	<2			
III-GW	1/13/04	1345	<10	<2	<10	<2			
VI-GW	2/17/04	1142	<10	<10 <2		<2			
VI-spring	2/17/04	1223	10	4	<10	2			
V-GW-new	2/19/04	1102	No counts obtain	ned because of	<10	6			
V-GW-house	2/19/04	1202	media failure.	Viable colonies	50	<2			
V-GW-silo	2/19/04	1134	picked and co	nfirmed as E. coli	<10	<2			
			Eastern Sh	ore					
II-GW	1/20/04	1115	<10	<2	<10	<2			
III-GW	1/20/04	1445	<10	<2	<10	2			
IV-GW	1/21/04	0915	<10	<2	<10	<2			
V-GW	1/21/04	1230	<10	<2	<10	2			

**Table 8.** Microbiological results for surface-water samples collected from Shenandoah Valley and Eastern Shore, Va.

[Virginia instantaneous water-quality standard for *E. coli* is 235 colony-forming units per 100 milliliters (units/100 mL); for enteroccoci, the standard is 61 colony-forming units/100 mL (9 VAC 25-260-170)]

0			E. coli	/100 mL	Enteroccoci/100 mL						
Sample identification	Date	Time	5-mL dilution	20-mL dilution	5-mL dilution	20-mL dilution					
	Shenandoah Valley										
II-B	1/12/04	1545	80 105 120								
I-A	1/13/04	0900	120	90	60	30					
I-B	1/13/04	0915	60	55	40	35					
VI-A	2/17/04	1353	<20	<5	<20	<5					
VI-B	2/17/04	1312	<20	5	<20	<5					
V-A	2/19/04	1228	No counts obtained	ed because of	20	80					
V-B	2/19/04	1258		Viable colonies -firmed as <i>E. coli</i>	40	65					
			Eastern Sho	ore							
II-A	1/20/04	1045	20	<5	80	25					
II-B	1/20/04	1145	40	<5	20	55					
III-A	1/20/04	1530	20	5	80	105					
III-B	1/20/04	1600	<20	<5	<20	40					
IV-A	1/21/04	0845	100	170	60	95					
IV-B	1/21/04	0815	<20	15	40	20					
V-A	1/21/04	1115	20	<5	60	25					
V-B	1/21/04	1145	160	185	80	120					

Table 9. Identification of bacterial isolates for samples collected from Shenandoah Valley, Va.

[a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

Sample	Colony			E. coli	Enter	ococci	Salmonella spp.	Can	npylobacter	spp.
identification	number	Date	Time	Identification	PYR Test	Lap Test	Identification	Oxidase	Catalase	Gram stain
II-B	1	1/12/04	1545	E. coli 1–82.2%	Positive	Positive	Not Tested with 20 E	Positive	Positive	Negative
	2			E. coli 1–99.1%	Negative	Negative	Not Tested with 20 E	Positive	Positive	Positive
	3			E. coli 1–99.1%	Positive	Positive	Not Tested with 20 E	Positive	Positive	Positive
	4			E. coli 1–96.5%	Positive	Positive	Salmonella spp.–97.5%			
	5			E. coli 1–82.2%	Positive	Positive	Salmonella spp.–97.5%			
	6			E. coli 1–96.5%	Positive	Positive	Salmonella spp.–97.5%			
	7			E. coli 1–82.2%	Negative	Negative	Not Salmonella spp. Not Tested			
	8			E. coli 1–96.5%	Positive	Positive	Enterobacter cloacae–91.0% Not Tested			
	9			E. coli 1–66.6%; Kluyvera spp.–32.4%	Positive	Positive	Salmonella spp.–97.5%			
	10			E. coli 1–99.6%	Positive	Positive	Salmonella spp.–97.5%			
II-GW	1	1/12/04	1515				Not Tested with 20 E			Negative
	2						Not Tested with 20 E			
	3						Not Tested with 20 E			
	4						Not Tested with 20 E			
	5						Not Tested with 20 E			
	6						Enterobacter spp. Not Tested			
	7						Hafnia alvei–99.4% Not Tested			
	8						Not Salmonella spp. Not Tested			
	9						Enterobacter spp. Not Tested			
	10						Not Tested with 20 E			
I-A	1	1/13/04	0900	E. coli 1–96.5%	Positive	Positive	Salmonella spp.–99.9%	Positive	Positive	Positive
	2			E. coli 1–96.5%	Positive	Positive	Salmonella spp.–99.9%			
	3			E. coli 1–97.7%	Positive	Positive	Not Tested with 20 E			
	4			E. coli 1–97.7%	Positive	Positive				
	5			E. coli 1–66.6%; Kluyvera spp.–32.4%	Positive	Positive				
	6			E. coli 1–97.7%	Positive	Positive				
	7			E. coli 1–90.5%	Positive	Positive				
	8			E. coli 1–96.5%	Positive	Positive				

**Table 9.** Identification of bacterial isolates for samples collected from Shenandoah Valley, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

Sample	Colony			E. coli	Enter	ococci	Salmonella spp.	Can	npylobacter	spp.
identification	Colony number	Date	Time	Identification	PYR Test	Lap Test	Identification	<b>O</b> xidase	Catalase	Gram stain
	9			E. coli 1–96.5%	Positive	Positive				
	10			E. coli 1–96.5%						
I-B	1	1/13/04	0915	E. coli 1–96.5%	Positive	Positive	Salmonella spp. –99.9%	Positive	Positive	Positive
	2			E. coli 1–96.5%	Positive	Positive	Salmonella spp. –99.9%			Negative
	3			E. coli 1–90.4%; E. coli 2–9.5%	Positive	Positive	Enterobacter spp. Not Tested			
	4			E. coli 1–82.0%; Kluyvera spp.–16.6%	Positive	Positive	Salmonella spp. –99.9%			
	5			E. coli 1–66.6%; Kluyvera spp.–32.4%	Not entere	ococci	Salmonella spp. –99.9%			
	6			E. coli 1–96.5%	Positive	Positive	Salmonella spp. –99.9%			
	7			E. coli 1–90.4%; E. coli 2–9.5%	Positive	Positive	Salmonella spp. –99.9%			
	8			E. coli 1–96.5%	Positive	Positive	Salmonella spp. –99.9%			
	9			E. coli 1–66.6%; Kluyvera spp.–32.4%	Positive	Positive	Salmonella spp. –99.9%			
	10			E. coli 1–96.5%			Salmonella spp. –99.9%			
I-GW	1	1/13/04	1030							
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
III-GW	1	1/13/04	1345							Negative
	2									
	3									
	4									
	5									
	6									
	7									
	8									

Table 9. Identification of bacterial isolates for samples collected from Shenandoah Valley, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

CI-	0-1			E. coli	Enter	ococci	Salmonella spp.	Can	npylobacter	spp.
Sample identification	Colony number	Date	Time	Identification	PYR Test	Lap Test	Identification	Oxidase	Catalase	Gram stain
	9									
	10						Not Salmonella spp.			
VI-GW	1	2/17/04	1142				Not Tested			
	2						Hafnia alvei–99.2%			
	3						Hafnia alvei–99.2%			
	4						Not Salmonella spp.  Not Tested			
	5						Not Salmonella spp. Not Tested			
	6						Not Salmonella spp. Not Tested			
	7						Not Salmonella spp.			
	8									
	9									
	10									
VI-B	1	2/17/04	1312	E. coli 1–96.5%			Not Salmonella spp.  Not Tested			Negative
	2						Not Salmonella spp. Not Tested			
	3						Not Salmonella spp. Not Tested			
	4									
	5									
	6									
	7									
	8									
	9									
	10									
VI-spring	1	2/17/04	1223	E. coli 1–96.5%	Positive	Positive	Not Salmonella spp. Not Tested			
	2			E. coli 1–96.5%			Not Salmonella spp.  Not Tested			
	3			E. coli 1–96.5%			Not Salmonella spp. Not Tested			
	4						Not Salmonella spp. Not Tested			
	5						Not Salmonella spp. Not Tested			
	6						Not rested			
	7									
	8									
	9									
	10									
V-A	1	2/19/04	1228	Not E. coli Not Tested	Positive	Positive	Salmonella spp.–97.5%			Negative

**Table 9.** Identification of bacterial isolates for samples collected from Shenandoah Valley, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

Sample	Colony			E. coli	Enter	ococci	Salmonella spp.	Can	npylobacte	rspp.
identification	number	Date	Time	Identification	PYR Test	Lap Test	Identification	Oxidase	Catalase	Gram stain
	2			E. coli 1–99.1%	Negative	Negative	Salmonella spp.–97.5%			
	3				Negative	Negative	Salmonella spp–97.5%			
	4				Negative	Negative	Salmonella spp.–97.5%			
	5				Not entere	ococci	Not Salmonella spp. Not Tested			
	6				Not enter	ococci	Salmonella spp.–97.5%			
	7				Not enter	ococci	Salmonella spp.–97.5%			
	8				Not enter	ococci	Salmonella spp. –97.5%			
	9				Not enter	ococci	Salmonella spp. –97.5%			
	10				Not enter	ococci	Salmonella spp. –97.5%			
V-B	1	2/19/04	1258	Not E. coli Not Tested	Negative	Negative				Negative
	2			Not E. coli Not Tested	Negative	Negative				
	3			Not E. coli Not Tested	Positive	Positive				
	4			E. coli 1–97.7%	Positive	Positive				
	5				Positive	Positive				
	6				Positive	Positive				
	7				Negative	Negative				
	8				Negative	Negative				
	9				Positive	Negative				
	10				Negative	Negative				
V-GW-new	1	2/19/04	1102		Negative	Positive				
	2				Positive	Positive				
	3				Positive	Positive				
	4									
	5									
	6									
	7									
	8 9									
	10									
V-GW-house	10	2/19/04	1202		Negative	Positive				Negative
Y G W House	2	2/17/01	1202		NG	NG				reguire
	3				NG	NG				
	4					erococci				
	5									
	6									
	7									
	8									
	9									
	10									

**Table 9.** Identification of bacterial isolates for samples collected from Shenandoah Valley, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

CI-	0-1			E. coli	Enter	ococci	Salmonella spp.	Can	npylobacter	spp.
Sample identification	Colony number	Date	Time	Identification	PYR Test	Lap Test	Identification	Oxidase	Catalase	Gram stain
V-GW-silo	1	2/19/04	1134		Negative Positive				Negative	
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									

 Table 10.
 Identification of bacterial isolates for samples collected from Eastern Shore, Va.

[a blank row indicates that 10 viable colonies were not available to analyze]

Sample	Colony		_	E. coli	Enterd	ococci	<i>Salmonella</i> spp.	Can	npylobacter	
identification	number	Date	Time	Identification	PYR Test	Lap Test	Identification	Oxidase	Catalase	Gram stain
II-A	1	1/20/04	1045	E. coli 1–96.5%	Positive	Positive				Negative
	2				Positive	Positive				
	3				Positive	Positive				
	4				Positive	Positive				
	5				Positive	Positive				
	6				Positive	Positive				
	7									
	8									
	9									
	10									
II-B	1	1/20/04	1145	E. coli 1–90.4%; E. coli 2–9.5%	Positive	Positive				
	2			E. coli 1–96.5%	Positive	Positive				
	3				Positive	Positive				
	4				Positive	Positive				
	5				Positive	Positive				
	6				Positive	Positive				
	7				Positive	Positive				
	8				Positive	Positive				
	9				Positive	Positive				
	10				Positive	Positive				
II-GW	1	1/20/04	1115							
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
III-A	1	1/20/04	1530	E. coli 1–82.0%; Kluyvera spp.–16.6%	Positive	Positive	Sal. spp.–55.5%; Hafnia alvei –44.2% Low Dis- crimination Not Tested			Negative
	2			E. coli 1–97.7%	Positive	Positive				
	3				Positive	Positive				
	4				Positive	Positive				
	5				Positive	Positive				
	6				Positive	Positive				
	7				Positive	Positive				
	8				Positive	Positive				

**20** 

**Table 10.** Identification of bacterial isolates for samples collected from Eastern Shore, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze]

Sample	Colony			E. coli	Enterd	ococci	Salmonella spp.	Can	npylobactei	
identification	number	Date	Time	Identification	PYR Test	Lap Test	Identification	Oxidase	Catalase	Gram stain
	9				Positive	Positive				
	10				Positive	Positive				
III-B	1	1/20/04	1600		Positive	Positive				
	2				Not ent	erococci				
	3				Not ente	erococci				
	4				Not ent	erococci				
	5				Not ente	erococci				
	6				Not ent	erococci				
	7				Not ent	erococci				
	8				Not ent	erococci				
	9									
	10									
III-GW	1	1/20/04	1445		Positive	Positive				
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
IV-A	1	1/21/04	0845	E. coli 1–99.1%	Positive	Positive				Negative
	2			E. coli 1–96.5%	Positive	Positive				
	3			E. coli 1–96.5%	Positive	Positive				
	4			E. coli 1–96.5%	Positive	Positive				
	5			E. coli 1–96.5%	Positive	Positive				
	6			E. coli 1–96.5%	Positive	Positive				
	7			E. coli 1–96.5%	Positive	Positive				
	8			E. coli 1–96.5%	Positive	Positive				
	9			E. coli 1–96.5%	Positive	Positive				
	10			E. coli 1–96.5%	Positive	Positive				
IV-B	1	1/21/04	0815	E. coli 1–96.5%	Positive	Positive	Not Tested with 20 E			
	2			E. coli 1–90.4%; E. coli 2–9.5%	Positive	Positive	Not Tested with 20 E			
	3			E. coli 1–96.5%	Positive	Positive				
	4				Positive	Positive				
	5				Positive	Positive				
	6				Positive	Positive				
	7									

**Table 10.** Identification of bacterial isolates for samples collected from Eastern Shore, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze]

Sample	Colony			E. coli	Enterd	ococci	Salmonella spp.	Can	npylobacter	spp.
identification	number	Date	Time	Identification	PYR Test	Lap Test	Identification	Oxidase	Catalase	Gram stain
	8									
	9									
	10									
IV-GW	1	1/21/04	0915							
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
V-A	1	1/21/04	1115	E. coli 1–96.5%	Positive	Positive	Edwardsiella tarda Not Tested	Positive	Positive	Positive
	2				Positive	Positive	Not Salmonella spp. Not Tested	Positive	Positive	Positive
	3				Positive	Positive	Kluyvera spp.–94.2% Not Tested			Negative
	4				Positive	Negative	Not Tested with 20 E			
	5				Positive	Positive				
	6				Positive	Positive				
	7				Positive	Positive				
	8				Positive	Positive				
	9									
	10									
V-B	1	1/21/04	1145	Not E. coli Not Tested	Positive	Positive				Negative
	2			Not E. coli Not Tested	Positive	Positive				
	3			Not E. coli Not Tested	Positive	Positive				
	4			Not E. coli Not Tested	Positive	Positive				
	5			Not E. coli Not Tested	Positive	Positive				
	6			Not E. coli Not Tested	Positive	Positive				
	7			Not E. coli Not Tested	Positive	Positive				
	8			Not E. coli Not Tested	Positive	Positive				

**Table 10.** Identification of bacterial isolates for samples collected from Eastern Shore, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze]

	0.1			E. coli	Enterd	ococci	Salmonella spp.	Can	npylobactei	spp.
Sample identification	Colony number	Date	Time	Identification	PYR Test	Lap Test	Identification	Oxidase	Catalase	Gram stain
	9			Not E. coli Not Tested	Positive	Positive				
	10			Not E. coli Not Tested	Positive	Positive				
V-GW	1	1/21/04	1230		Negative	Negative				Negative
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									

 Table 11.
 Antibiotic zone size interpretation guidelines.

<, less than or equal to; >, greater than or equal to]

	C	Controls		Isolates	
Antibiotic	<i>E. coli</i> ATCC # 25922	Staphylococcus aureus ATCC # 25923	Resistant	Intermediate	Susceptible
Amikacin	19–26	20–26	< 14	15–16	> 17
Bacitracin		12–22	< 8	9–12	> 13
Ceftiofur	26–31	37–31	< 17	18-20	> 21
Ciprofloxacin	30-40	22–30	< 15	16–20	> 21
Clindamycin		24–30	< 14	15-20	> 21
Erythromycin		22-30	< 13	14-22	> 23
Gentamicin	19–26	19–27	< 12	13-14	> 15
Neomycin	17–23	18–26	< 12	13–16	> 17
Penicillin		26–37	< 14		> 15
Spectinomycin	21–25	13–17	< 10	11–13	> 14
Streptomycin	12-20	14–22	< 11	12-14	> 15
Tetracycline	18–25	24–30	< 14	15-18	> 19
Tilmicosin		17–21	< 10	11–13	> 14
Trimethoprim	21–28	19–26	< 10	11–15	> 16
Vancomycin		17–21	< 14	15–16	> 17

 Table 12.
 Antibiotic sensitivities for E. coli for samples collected from Shenandoah Valley, Va.

[Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony number	Date	Time		Amkacın		Certiorur	i companio		Noomioin		Chootingminin	Specimoniyem	Ctero ato	orieptomyciii	Tottogodino	ieu acyciiile		ігітетпоргіт
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
II-B	1	1/12/04	1545	22	S	23	S	21	S	19	S	20	S	17	S	21	S	25	S
	2			21	S	24	S	22	S	17	S	20	S	14	I	20	S	25	S
	3			22	S	24	S	17	S	17	S	21	S	15	S	19	S	27	S
	4			20	S	26	S	21	S	18	S	20	S	15	S	19	S	24	S
	5			22	S	26	S	22	S	19	S	20	S	16	S	20	S	25	S
	6			20	S	24	S	20	S	16	I	20	S	12	I	21	S	24	S
	7			22	S	24	S	21	S	16	I	21	S	15	S	7.5	R	25	S
	8			21	S	23	S	20	S	17	S	19	S	15	S	20	S	26	S
	9			21	S	23	S	21	S	18	S	20	S	14	I	20	S	24	S
	10			21	S	24	S	20	S	18	S	20	S	14	I	19	S	21	S
II-GW	1	1/12/04	1515																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
<b>.</b> .	10	1 11 2 10 1	0000			2.4		20	<b>a</b>	4.0		20				•		2.2	
I-A	1	1/13/04	0900	21	S	24	S	20	S	18	S	20	S	15	S	20	S	23	S
	2			20 20	S	22	S	20	S	17	S	20	S	14	I	19 20	S	24	S
	3			20	S S	24 22	S S	20	S S	16 18	I S	19 20	S S	16 13	S I	19	S S	20	S S
	5			19	S	23	S	20	S	18	S	19	S	13	I	20	S	20	S
	6			19	S	23	S	20	S	20	S	20	S	12	I	20	S	20	S
	7			22	S	25	S	20	S	18	S	19	S	15	S	20	S	23	S
	8			21	S	23	S	21	S	19	S	19	S	15	S	21	S	24	S
	9			21	S	24	S	20	S	17	S	22	S	15	S	18	I	22	S
	10			23	S	24	S	20	S	17	S	20	S	15	S	19	S	23	S
I-B	1	1/13/04	0915	22	S	27	S	22	S	17	S	20	S	13	I	20	S	25	S
	2			21	S	25	S	22	S	19	S	21	S	16	S	12	R	25	S
	3			22	S	26	S	20	S	19	S	20	S	14	I	20	S	24	S
	-				~								-		-		-		-

**Table 12.** Antibiotic sensitivities for *E. coli* for samples collected from Shenandoah Valley, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony number	Date	Time		Amikacın	, 0	celliolur			nionano N	Meonilyciii		Specimoniyem	Ottontomorphic and a series of the series of	Streptomycin	Tottoconino	leuacyciiie	14000	Irimethoprim
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	4			22	S	25	S	20	S	18	S	20	S	13	I	20	S	24	S
	5			21	S	29	S	23	S	18	S	20	S	16	S	20	S	30	S
	6			23	S	26	S	20	S	18	S	21	S	16	S	12	R	25	S
	7			23	S	27	S	20	S	20	S	21	S	14	I	20	S	25	S
	8			23	S	26	S	21	S	7.5	R	14	S	10	R	7.5	R	29	S
	9			24	S	28	S	21	S	19	S	25	S	15	S	19	S	30	S
	10			22	S	26	S	21	S	17	S	21	S	16	S	20	S	26	S
I-GW	1	1/13/04	1030																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
III-GW	1	1/13/04	1345																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-A	1	2/17/04	1353																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		

**26** 

**Table 12.** Antibiotic sensitivities for *E. coli* for samples collected from Shenandoah Valley, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony number	Date	Time		Amikacin		Cermonn	i cim		Noomooin			Specimoniyem	Ofton of the control	ouepromy cin	Totrocuolino	ieu acyciiile	1	
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	8																		
	9																		
	10																		
VI-B	1	2/17/04	1312	23	S	27	S	23	S	17	S	23	S	15	S	15	I	25	S
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-GW	1	2/17/04	1142																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10	2/17/04	1000	22	C	27		22		10		22		1.5		22		20	
VI-spring	1	2/17/04	1223	22	S	27	S	23	S	19	S	23	S	15	S	22	S	29	S
	2 3			22 20	S					19 18						20			
	4			20	3	23	3	21	3	10	3	21	3	14	1	19	3	23	3
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
	10																		

**Table 12.** Antibiotic sensitivities for *E. coli* for samples collected from Shenandoah Valley, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony number	Date	Time	Amikacin		Ceftiofur		Gentamicin		Neomycin		Spectinomycin		Streptomycin		Tetracycline		Trimethoprim	
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	e Guide	Zone size	Guide
V-A	1	2/19/04	1228																
	2			20	S	26	S	21	S	19	S	22	S	15	S	19	S	26	S
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-B	1	2/19/04	1258																
	2																		
	3					2.5		10	_	20					_		_	2.	
	4			22	S	25	S	10	R	20	S	13	I	7.5	R	7.5	R	26	S
	5 6																		
	7																		
	8																		
	9																		
	10																		
V-GW-new	1	2/19/04	1102																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-GW-house	1	2/19/04	1202																
	2																		
	3																		

**Table 12.** Antibiotic sensitivities for *E. coli* for samples collected from Shenandoah Valley, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony number	Date	Time	amil Amikacin		Ceftiofur		Gentamicin		Neomycin		Spectinomycin		Streptomycin		Tetracycline		Trimethoprim	
idontinodaton				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
V-GW-silo	10 1	2/19/04	1134																
v-Gw-siio	2	2/19/04	1134																
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		

[Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony number	Date	Time	Ceftiofur		:000	cipromoxaciii		Medinyciii	Streptomycin		Tetracycline	
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	21 18 18 18	Guide
II-A	1	1/20/04	1045	24	S	33	S	17	S	12	I	21	S
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
II_R	10												
II-B	1	1/20/04	1145	25	S	34	S	18	S	17	S		I
	2			25	S	36	S	17	S	16	S	18	I
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
II-GW	1	1/20/04	1115										
	2												
	3												
	4												
	5 6												
	7												
	8												
	9												
	10												
III-A	10	1/20/04	1530	24	S	32	S	10	R	7.5	R	7.5	R
m A	2	1/20/07	1330	24	S		S	10	R	7.5	R		R
	3			<u>~</u> ⊤	5	32	5	10		,.5	11	, .5	11
	4												

**Table 13.** Antibiotic sensitivities for *E. coli* for samples collected from Eastern Shore, Va.—Continued

[Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony number	Date	Time			i ocycler	Ciprolloxaciii	Noomioin	Meonily cili	Streptomycin		Totroccino	leuacycille
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	5												
	6												
	7												
	8												
	9												
	10												
III-B	1	1/20/04	1600										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
III-GW	1	1/20/04	1445										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
IV-A	1	1/21/04	0845	23	S	30	S	15	I	13	I	16	I
	2			23	S	27	S	17	S	14	I	20	S
	3			23	S	29	S	18	S	15	S	20	S
	4			24	S	30	S	17	S	16	S	20	S
	5			25	S	29	S	17	S	14	Ι	19	S
	6			24	S	32	S	17	S	14	Ι	21	S
	7			23	S	30	S	17	S	14	Ι	22	S
	8			24	S	30	S	17	S	14	I	22	S

**Table 13.** Antibiotic sensitivities for *E. coli* for samples collected from Eastern Shore, Va.—Continued

Sample identification	Colony number	Date	Time		nionia.		cipronoxacin		Medinyciii	Chando	Streptomycin	Total	leuacyciiile
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	9			23	S	31	S	17	S	15	S	21	S
	10			26	S	39	S	18	S	13	I	19	S
IV-B	1	1/21/04	0815	26	S	32	S	15	I	13	I	19	S
	2			25	S	28	S	16	Ι	15	S	19	S
	3			24	S	32	S	17	S	15	S	20	S
	4												
	5												
	6												
	7												
	8												
	9												
	10												
IV-GW	1	1/21/04	0915										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
V-A	1	1/21/04	1115	26	S	35	S	18	S	16	S	21	S
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
V-B	1	1/21/04	1145										
	2												
	-												

**Table 13.** Antibiotic sensitivities for *E. coli* for samples collected from Eastern Shore, Va.—Continued

Sample identification	Colony number	Date	Time	Cofficient	Cention		Ciprolloxaciii	Noomioin		C. C	Streptomycin	Totracvolina	leuacycille
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
V-GW	1	1/21/04	1230										
	2												
	3												
	4												
	5												
	6 7												
	8												
	9												
	10												

 Table 14.
 Antibiotic sensitivities for enterococci for samples collected from Shenandoah Valley, Va.

Sample identification	Colony number	Date	Time		Allinaciii		Dacin aciii	1190			Ciindamycin	ioimoja ioimoja		Noomo	Meoniy cili	illicia d		Chootinomucin		Othorito in	on epromyciii	Totrocorpino	ieu acyciiile	Timicosin		Timoshowin	пишеториш
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
II-B	1	1/12/04	1545	14	R	15	S	12	R	7.5	R	15	S	14	I	21	S	18	S	7.5	R	27	S	15	S	34	S
	2																										
	3			13	R	12	I	20	I	7.5	R	15	S	11	R	24	S	18	S	7.5	R	25	S	13	I	32	S
	4			14	R	15	S	15	R	7.5	R	16	S	16	I	24	S	14	S	7.5	R	26	S	15	S	36	S
	5			7.5	R	16	S	7.5	R	7.5	R	10	R	7.5	R	18	S	9	R	7.5	R	25	S	10	R	26	S
	6			7.5	R	14	S	7.5	R	7.5	R	7.5	R	7.5	R	17	S	9	R	7.5	R	22	S	7.5	R	23	S
	7																										
	8			12	R	12	I	14	R	7.5	R	13	I	11	R	23	S	11	I	9	R	22	S	13	I	30	S
	9			13	R	13	S	15	R	7.5	R	15	I	15	I	24	S	18	S	7.5	R	23	S	13	I	33	S
	10			11	R	13	S	22	S	7.5	R	12	R	12	R	25	S	17	S	10	R	19	S	11	I	29	S
II-GW	1	1/12/04	1515																								
	2																										
	3																										
	4																										
	5																										
	6																										
	7																										
	8																										
	9																										
	10																										
I-A	1	1/13/04	0900	7.5	R	14	S	7.5	R	7.5	R	11	R	7.5	R	19	S	13	I	7.5	R	23	S	11	Ι	23	S
	2			8	R	19	S	12	R	7.5	R	10	R	10	R	22	S	11	Ι	7.5	R	7.5	R	10	R	33	S
	3			7.5	R	19	S	7.5	R	7.5	R	9	R	9	R	20	S	10	R	7.5	R	7.5	R	9	R	36	S
	4			7.5	R	14	S	7.5	R	7.5	R	9	R	9	R	17	S	7.5	R	7.5	R	20	S	7.5	R	26	S
	5			8	R	16	S	7.5	R	7.5	R	10	R	10	R	18	S	10	R	7.5	R	21	S	16	S	26	S
	6			15		15										19								13			
	7																							13			
	8																							7.5			
	9			7.5	R	12	1	7.5	R	7.5	R	7.5	R	7.5	R	19	S	9	R	7.5	R	19	S	7.5	R	26	S
I D	10	1/10/04	0015	10	D	12	c	11	ъ	7.	ъ	10	Y	1.1	D	2.4	c	1.5	C	7.	D	10	c	11	Y	20	c
I-B	1	1/12/04	0915																							30	
	2																							9		20	
	3																							10		21	
	4 5			14	K	13	3	1.3	K	1.3	K	13	3	13	1	19	3	13	1	1.3	К	1.3	К	10	К	1.3	K
				11	р	12	c	75	D	7.5	D	14	ĭ	12	р	10	c	16	c	7.5	р	25	c	15	c	32	c
	6																							15			
	7			15	1	15	S	9	K	7.5	K	15	S	16	1	20	S	17	S	1.5	K	24	S	15	S	51	S

**Table 14.** Antibiotic sensitivities for enterococci for samples collected from Shenandoah Valley, Va.—Continued

[Antibiotic disc zone size given in millimeters: R\_resistant: L\_intermediate: S\_susceptible: a blank row indicates that 10 viable colonies were not available.

Sample identification	Colony number	Date	Time		AIIIIKaCIII	Rocitrocin	Dacinaciii	Cofficient		S. S	cimaamycin	Gontamioin			меошусп		Leuicillu Leuici		эресипошуси	ě	Streptomycin		letracycille	Tilmicocin		Trimothonrim	
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	8			12	R	14	S	10	R	7.5	R	14	I	14	I	17	S	13	I	7.5	R	22	S	12	I	30	S
	9			13	R	15	S	20	I	8	R	15	S	13	I	24	S	12	I	11	R	21	S	13	I	43	S
	10																										
I-GW	1	1/13/04	1030																								
	2																										
	3																										
	4																										
	5																										
	6																										
	7																										
	8																										
	9																										
	10																										
III-GW	1	1/13/04	1345																								
	2																										
	3																										
	4																										
	5																										
	6																										
	7																										
	8																										
	9																										
	10																										
VI-A	1	2/17/04	1353																								
	2																										
	3																										
	4																										
	5																										
	6																										
	7 8																										
	9																										
	10																										
VI-B	10	2/17/04	1312																								
.1.5	2	<i>2</i> /1//∪ <del>1</del>	1.11																								
	3																										
	4																										
	5																										

Table 14. Antibiotic sensitivities for enterococci for samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time		Amikacin	1	Dacillacill	i definition			cimaamycim				меошусп	illioi ao		Cnootingmicin	specimoniyem	Chromoponia	onepromyciii	Totograph	leuacyciille	T.			ігіметпоргім
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	6																										
	7																										
	8																										
	9																										
	10																										
VI-GW	1	2/17/04	1142																								
	2																										
	3																										
	4																										
	5																										
	6																										
	7																										
	8																										
	9																										
	10																										
VI-spring	1	2/17/04	1223	15	I	8	R	21	S	7.5	R	14	I	11	R	25	S	16	S	7.5	R	21	S	14	S	30	S
	2																										
	3																										
	4																										
	5																										
	6																										
	7																										
	8																										
	9																										
	10																										
V-A	1	2/19/04	1228	13	R	7.5	R	7.5	R	7.5	R	7.5	R	16	I	18	S	13	Ι	7.5	R	7.5	R	13	I	22	S
	2																										
	3																										
	4																										
	5																										
	6																										
	7																										
	8																										
	9																										
	10																										
V-B	1	2/19/04	1258																								
	2																										

Table 14. Antibiotic sensitivities for enterococci for samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time		AIIIKaciii			Cofficient			cimaamycin	i cimento di			Neomycin	:::::::::::::::::::::::::::::::::::::::			Specunomycin		Streptomycin	- Total	leuacycime	Tilmicocin		Trimothonim	Irimethoprim
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	3			7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	10	R	30	S
	4			7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	7.5	R	10	R	33	S
	5			11	R	7.5	R	7.5	R	7.5	R	13	I	7.5	R	7.5	R	16	S	7.5	R	7.5	R	7.5	R	30	S
	6			10	R	7.5	R	7.5	R	7.5	R	7.5	R	18	S	7.5	R	7.5	R	7.5	R	7.5	R	11	I	33	S
	7																										
	8																										
	9																										
	10																										
V-GW-new	1	2/19/04	1102																								
	2			13	R	11	I	12	R	7.5	R	15	S	15	I	23	S	12	I	7.5	R	20	S	12	I	24	S
	3			13	R	12	Ι	7.5	R	7.5	R	13	I	16	I	22	S	11	Ι	7.5	R	20	S	12	I	23	S
	4																										
	5 6																										
	7																										
	8																										
	9																										
	10																										
V-GW-house	1	2/19/04	1202																								
	2																										
	3																										
	4																										
	5																										
	6																										
	7																										
	8																										
	9																										
	10																										
V-GW-silo	1	2/19/04	1134																								
	2																										
	3																										
	4																										
	5																										
	6																										
	7 8																										
	8 9																										
	10																										

 Table 15.
 Antibiotic sensitivities for enterococci for samples collected from Eastern Shore, Va.

Sample identification	Colony number	Date	Time		Dacinaciii	Cofficient		Cinyofloxogin		Clindomycin		1	Eryunomycin	Moomio		Donicillin			onepromyciii	Totracycline			Vancomycın
identification	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
II-A	1	1/20/04	1045	10	I	12	R	21	S	7.5	R	23	S	14	I	20	S	10	R	15	I	15	I
	2			16	S	7.5	R	7.5	R	7.5	R	7.5	R	10	R	16	S	7.5	R	19	S	15	I
	3			12	I	7.5	R	11	R	9	R	15	I	17	S	17	S	7.5	R	7.5	R	20	S
	4			9	I	7.5	R	18	I	7.5	R	20	I	13	I	18	S	8	R	20	S	16	I
	5			9	I	7.5	R	18	I	7.5	R	18	I	13	I	16	S	9	R	16	I	16	I
	6			9	I	7.5	R	17	I	7.5	R	23	S	15	I	15	S	10	R	20	S	18	S
	7																						
	8																						
	9																						
	10																						
II-B	1	1/20/04	1145	12	I	17	R	16	I	7.5	R	21	I	12	R	25	S	7.5	R	22	S	20	S
	2			9	I	7.5	R	15	R	7.5	R	15	I	8	R	17	S	7.5	R	20	S	15	I
	3			15	S	27	S	20	I	7.5	R	20	I	14	I	18	S	7.5	R	23	S	21	S
	4			17	S	36	S	18	I	28	S	32	S	17	S	37	S	7.5	R	25	S	25	S
	5			19	S	27	S	25	S	7.5	R	24	S	13	Ι	37	S	7.5	R	25	S	20	S
	6			14	S	7.5	R	14	R	7.5	R	15	I	16	I	19	S	7.5	R	7.5	R	19	S
	7			17	S	7.5	R	21	S	7.5	R	16	I	10	R	14	R	7.5	R	15	I	16	Ι
	8			14	S	7.5	R	21	S	7.5	R	27	S	16	I	23	S	7.5	R	7.5	R	20	S
	9			15	S	7.5	R	19	I	7.5	R	18	I	15	I	20	S	7.5	R	7.5	R	17	S
	10			13	S	7.5	R	20	S	7.5	R	21	I	16	I	21	S	7.5	R	7.5	R	19	S
II-GW	1	1/20/04	1115																				
	2																						
	3																						
	4																						
	5																						
	6																						
	7																						
	8																						
	9																						
	10																						
III-A	1	1/20/04	1530	13	S	20	I	13	R	31	S	19	I	15	I	23	S	9	R	7.5	R	20	S
	2			11	I	8	R	19	I	7.5	R	15	I	10	R	18	S	7.5	R	17	I	17	S
	3			9	I	7.5	R	17	I	7.5	R	15	I	9	R	17	S	7.5	R	21	S	15	I
	4			9	I	15	R	20	I	7.5	R	16	S	13	I	24	S	10	R	25	S	20	S
	5			11	Ι	16	R	18	I	7.5	R	20	I	11	R	23	S	7.5	R	20	S	17	S

**Table 15.** Antibiotic sensitivities for enterococci for samples collected from Eastern Shore, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony number	Date	Time		Dacillaciii	Coffice		i ocyclistic	orpromovaciii	Clindamycin		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Eryun Olliny Cilli	Noomioin		Donicillin		Ctrontomocin	and and and	Totracvelina		Voncentein	Vancomycin
identification	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	6			9	I	18	I	12	R	7.5	R	19	I	13	I	24	S	7.5	R	16	I	18	S
	7			10	I	17	R	17	I	7.5	R	19	I	12	R	21	S	7.5	R	20	S	19	S
	8			8	R	14	R	18	I	7.5	R	13	R	11	R	22	S	7.5	R	23	S	18	S
	9			9	I	13	R	17	I	7.5	R	13	R	11	R	19	S	7.5	R	18	I	17	S
	10			8	R	17	R	18	I	7.5	R	16	I	13	I	25	S	7.5	R	24	S	17	S
III-B	1	1/20/04	1600	14	S	7.5	R	14	R	7.5	R	15	I	7.5	R	18	S	7.5	R	21	S	14	R
	2																						
	3																						
	4																						
	5																						
	6																						
	7																						
	8																						
	9																						
III CW	10	1/20/04	1445	12		7.5	D	20	т	7.5	D	16		10	D	17	C	7.5	D	20	C	16	т
III-GW	1 2	1/20/04	1445	12	I	7.5	R	20	Ι	7.5	R	16	Ι	10	R	17	S	7.5	R	20	S	16	Ι
	3																						
	4																						
	5																						
	6																						
	7																						
	8																						
	9																						
	10																						
IV-A	1	1/21/04	0845	16	S	10	R	21	S	7.5	R	21	Ι	14	I	21	S	7.5	R	23	S	22	S
	2			17	S	7.5	R	23	S	7.5	R	19	I	12	R	15	S	7.5	R	19	S	16	I
	3			10	I	19	I	19	I	7.5	R	19	I	10	R	27	S	7.5	R	25	S	19	S
	4			14	S	7.5	R	21	S	7.5	R	20	I	13	I	20	S	7.5	R	23	S	22	S
	5			16	S	10	R	21	S	7.5	R	19	I	13	I	19	S	7.5	R	21	S	21	S
	6			14	S	9	R	20	I	7.5	R	20	Ι	13	I	19	S	7.5	R	23	S	21	S
	7			16	S	10	R	21	S	7.5	R	20	I	13	I	21	S	7.5	R	22	S	21	S
	8			15	S	9	R	20	I	7.5	R	20	I	13	I	20	S	7.5	R	24	S	20	S
	9			11	I	16	R	18	I	7.5	R	18	I	10	R	26	S	7.5	R	24	S	18	S
	10			14	S	10	R	20	I	7.5	R	19	I	14	I	21	S	7.5	R	25	S	21	S

**Table 15.** Antibiotic sensitivities for enterococci for samples collected from Eastern Shore, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample	Colony	Date	Time		Daciuaciii		in ionina	i cos di cari	cipionoxaciii	Clindomycoin	iii aaiii aaii		Eryuiroiiiyciii	Noomoon a	Medinyciii	Donicillin		Standard Standard	Streptomycin	Totrocyclino	ieuacyciiie		Vancomycin
identification	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
IV-B	1	1/21/04	0815	17	S	20	I	19	I	7.5	R	23	S	10	R	18	S	7.5	R	24	S	16	I
	2			11	I	7.5	R	20	I	12	R	7.5	R	16	I	19	S	7.5	R	20	S	17	S
	3			12	Ι	7.5	R	20	I	14	R	7.5	R	15	I	16	S	7.5	R	21	S	20	S
	4			12	I	7.5	R	17	I	7.5	R	19	I	13	I	20	S	7.5	R	18	I	17	S
	5			13	S	7.5	R	20	I	7.5	R	7.5	R	16	I	20	S	7.5	R	7.5	R	19	S
	6			16	S	21	S	18	I	7.5	R	21	I	8	R	19	S	7.5	R	21	S	16	I
	7																						
	8																						
	9																						
	10																						
IV-GW	1	1/21/04	0915																				
	2																						
	3																						
	4																						
	5																						
	6																						
	7																						
	8 9																						
	10																						
V-A		1/21/04	1115	15	S	7.5	R	21	S	7.5	R	10	R	7.5	R	21	S	7.5	R	7.5	R	21	c
V-A	1 2	1/21/04	1113	14	S	7.5	R	22	S	11	R	10	R	16	I	22	S	7.5	R	26	S	20	S S
	3			13	S	7.5	R	18	I	9	R	30	S	12	R	20	S	7.5	R	25	S	22	S
	4			13	3	1.5	K	10	1		IX	30	5	12	K	20	J	7.5	IX	23	5	22	3
	5			10	ī	7.5	R	14	R	17	ī	18	ī	16	I	21	S	7.5	R	7.5	R	19	S
	6			11	I					7.5								7.5		22	S	19	S
	7									7.5													
	8									7.5													
	9																						
	10																						
V-B	1	1/21/04	1145	13	S	23	S	13	R	23	S	12	R	15	Ι	28	S	7.5	R	9	R	18	S
	2									16													
	3			11	I	7.5	R	10	R	21	S	11	R	16	I	26	S	7.5	R	8	R	19	S
	4			12	I	21	S	11	R	21	S	11	R	16	I	25	S	7.5	R	7.5	R	20	S
	5			16	S	7.5	R	20	I	7.5	R	14	I	18	S	25	S	10	R	7.5	R	20	S

**Table 15.** Antibiotic sensitivities for enterococci for samples collected from Eastern Shore, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony	Date	Time	1004100	Daciuaciii	, 190		Cinroflovacin	III OBVOIDING TO THE TOTAL TO T	Clindsmycin		4	Eryunomycin	No.	Medinyciii	:::::::::::::::::::::::::::::::::::::::		Otto at out	onepromyciii	Totto	leuacyciile		vancomycin
identification	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	6			15	S	7.5	R	20	I	7.5	R	19	I	13	I	16	S	7.5	R	20	S	20	S
	7			11	I	20	I	10	R	16	I	12	R	16	I	26	S	7.5	R	7.5	R	19	S
	8			12	I	24	S	12	R	22	S	13	R	12	R	25	S	7.5	R	7.5	R	18	S
	9			13	S	23	S	12	R	23	S	11	R	17	S	26	S	7.5	R	7.5	R	19	S
	10			12	I	25	S	12	R	22	S	11	R	16	I	27	S	7.5	R	7.5	R	20	S
V-GW	1	1/21/04	1230																				
	2																						
	3																						
	4																						
	5																						
	6																						
	7																						
	8																						
	9																						
	10																						

**Table 16.** Antibiotic sensitivities for *Salmonella* spp. for samples collected from Shenandoah Valley, Va.

Sample identification	Colony number	Date	Time	Amikacin	Allikaciii	,0			delicallicili	Neomycin	•	Crootingminin	opecunomycin		Streptonnycin	1	letracyciine		Irimethoprim
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
II-B	1	1/12/04	1545																
	2																		
	3																		
	4			20	S	23	S	22	S	20	S	20	S	14	I	20	S	25	S
	5			21	S	24	S	20	S	20	S	21	S	14	I	20	S	24	S
	6			20	S	23	S	21	S	20	S	20	S	14	I	19	S	24	S
	7																		
	8																		
	9			20	S	24	S	20	S	21	S	20	S	14	I	20	S	25	S
	10			21	S	24	S	22	S	19	S	20	S	14	I	20	S	25	S
II-GW	1	1/12/04	1515																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
T. A.	10	1/12/04	0000	22	G	22		2.4	C	22.5		22	C	1.1		20		26	G
I-A	1	1/13/04	0900	23	S	23	S	24	S	23.5	S	23	S	14	I	20	S	26	S
	2			22	S	23	S	22	S	22	S	23	S	13	Ι	15	Ι	23	S
	3																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
I-B	1	1/13/04	0915	23	S	26	S	20	S	20	S	20	S	14	I	20	S	25	S
	2				S			21		-	-	20		14	I	20	S	24	
	3																		

**Table 16.** Antibiotic sensitivities for *Salmonella* spp. for samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time	Amikacin	Allinacian Allinacian	2,17	cention		Gentamicin	Neomycin			Specunomycin		streptomycin	<u>.</u>	letracyciine	· -	Trimethoprim
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	5			22	S	22	S	20	S	20	S	19	S	13	I	17	I	24	S
	6			22	S	24	S	21	S	20	S	18	S	14	I	14	R	24	S
	7			22	S	22	S	20	S	20	S	18	S	14	I	17	Ι	25	S
	8			22	S	26	S	23	S	20	S	25	S	14	I	18	I	26	S
	9			21	S	24	S	19	S	19	S	21	S	14	I	19	S	25	S
	10			22	S	24	S	21	S	22	S	22	S	14	I	20	S	25	S
I-GW	1	1/13/04	1030																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10	1/12/01	1015																
III-GW	1	1/13/04	1345																
	2 3																		
	3 4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-A	1	2/17/04	1353																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		

**Table 16.** Antibiotic sensitivities for *Salmonella* spp. for samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time	Amikaoin	AIIIIKACIII		Celtionar	,		Neomycin			opecunomycin		Streptonnycin		ietracyciine		
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	10																		
VI-B	1	2/17/04	1312																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-GW	1	2/17/04	1142																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	10																		
VI-spring	1	2/17/04	1223																
v 1-spring	2	2/17/04	1223																
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-A	1	2/19/04	1228	22	S	21	S	21	S	18	S	20	S	13	I	19	S	22	S
	2			21	S	24	S	21	S	19	S	17	S	12	I	18	Ι	22	S
	3			21	S	24	S	19	S	18	S	17	S	12	I	19	S	21	S
	4			22	S	22	S	19	S	19	S	18	S	12	I	18	I	20	S
	5																		

**Table 16.** Antibiotic sensitivities for *Salmonella* spp. for samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time	Amikacin	Allikaciii	,01	cention		Gentamicin	Neomycin		Caootinomyoin	speculioniyeiii		Streptomycin	<u>.</u>	letracycline	· -	Irimethoprim
	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	6			22	S	22	S	19	S	18	S	18	S	12	I	19	S	20	S
	7			21	S	22	S	20	S	18	S	18	S	11	R	18	I	22	S
	8			22	S	23	S	20	S	19	S	17	S	12	Ι	20	S	22	S
	9			21	S	23	S	21	S	20	S	17	S	11	R	18	I	21	S
	10			21	S	23	S	20	S	18	S	18	S	11	R	18	I	21	S
V-B	1	2/19/04	1258																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-GW-new	1	2/19/04	1102																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
V-GW-house	10 1	2/19/04	1202																
v-G vv-House	2	<i>4</i> / 19/0 <del>4</del>	1202																
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		

**Table 16.** Antibiotic sensitivities for *Salmonella* spp. for samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time	Amiltonin	AIIIIKaciiii		септопиг		Gentamicin	Neomycin			specimoniyem		Streptomycin		letracyciine	F	
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
V-GW-silo	1	2/19/04	1134																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		

**Table 17.** Antibiotic sensitivities for *Salmonella* spp. for samples collected from Eastern Shore, Va.

Sample identification	Colony number	Date	Time	Cofficeing			Cipronoxacin		меошуспи	ė	streptomycin	<u>.</u>	letracycime
identification	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
II-A	1	1/20/04	1045										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
II-B	1	1/20/04	1145										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
II-GW	1	1/20/04	1115										
	2												
	3												
	4												
	5												
	6 7												
	8 9												
III A	10	1/20/04	1520										
III-A	1	1/20/04	1530										
	2 3												
	4												
	5												
	3												

**Table 17.** Antibiotic sensitivities for *Salmonella* spp. for samples collected from Eastern Shore, Va.—Continued

Sample identification	Colony number	Date	Time	Coffine		::0000	cipronoxaciii		Neomyciii		streptomycin	-	letracycine
identification	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	6												
	7												
	8												
	9												
	10												
III-B	1	1/20/04	1600										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
III-GW	1	1/20/04	1445										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
IV-A	1	1/21/04	0845										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												

**Table 17.** Antibiotic sensitivities for *Salmonella* spp. for samples collected from Eastern Shore, Va.—Continued

Sample	Colony	Date	Time	i de i		110000	cipromoxaciii		Neomycin		Streptomycin		letracyciiie
identification	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
IV-B	1	1/21/04	0815										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
IV-GW	1	1/21/04	0915										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
X7. A	10	1/21/04	1115										
V-A	1	1/21/04	1115										
	2												
	3 4												
	5												
	6												
	7												
	8												
	9												
	10												
V-B	1	1/21/04	1145										
. 2	2	1,21,01	1110										
	3												
	4												
	5												
	6												

**Table 17.** Antibiotic sensitivities for *Salmonella* spp. for samples collected from Eastern Shore, Va.—Continued

Sample	Colony	Date	Time	Cofficence		::000	стргопохаст	a composition	Neomyciii		streptomycin		ietracycime
identification	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	7												
	8												
	9												
	10												
V-GW	1	1/21/04	1230										
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												

 Table 18.
 Metal concentrations in water samples collected from Shenandoah Valley, Va.

[ ppm, parts per million;  $\mu$ g/L, micrograms per liter; < less than]

Sample identification	Date	Time	Hardness, ppm	Chromium, µg/L	Nickel, μg/L	Copper, µg/L	Arsenic, μg/L	Cadmium, µg/L	Mercury, μg/L
II-B	1/12/04	1545	318	< 10	< 10	< 10	<5	<5	< 0.3
II-GW	1/12/04	1515	406	< 10	< 10	< 10	<5	<5	<.3
I-A	1/13/04	0900	300	< 10	< 10	< 10	<5	<5	<.3
I-B	1/13/04	0915	268	< 10	< 10	< 10	<5	<5	<.3
I-GW	1/13/04	1030	330	< 10	< 10	< 10	<5	<5	.8
III-GW	1/13/04	1345	319	< 10	< 10	13.7	<5	<5	<.3
VI-A	2/17/04	1353	49	< 10	< 10	< 10	<5	<5	<.3
VI-B	2/17/04	1312	56	< 10	< 10	< 10	<5	<5	<.3
VI-GW	2/17/04	1142	519	< 10	< 10	< 10	<5	<5	<.3
VI-spring	2/17/04	1223	275	< 10	< 10	< 10	<5	<5	<.3
V-A	2/19/04	1228	158	< 10	< 10	< 10	<5	<5	<.3
V-B	2/19/04	1258	136	< 10	< 10	< 10	<5	<5	<.3
V-GW-new	2/19/04	1102	6	< 10	< 10	11	<5	<5	<.3
V-GW-house	2/19/04	1202	329	< 10	< 10	47.3	<5	<5	<.3
V-GW-silo	2/19/04	1134	371	< 10	< 10	36.8	<5	<5	<.3

Table 19. Metal concentrations in water samples collected from Eastern Shore, Va.

[ ppm, parts per million;  $\mu g/L$ , micrograms per liter; < less than]

Sample identification	Date	Time	Hardness, ppm	Chromium, µg/L	Nickel, μg/L	Copper, µg/L	Arsenic, µg/L	Cadmium, µg/L	Mercury, μg/L
II-A	1/20/04	1045	42	< 10	< 10	< 10	<5	<5	< 0.3
II-B	1/20/04	1145	55	< 10	< 10	< 10	<5	<5	<.3
II-GW	1/20/04	1115	95	< 10	< 10	< 10	<5	<5	<.3
III-A	1/20/04	1530	48	< 10	< 10	< 10	<5	<5	<.3
III-B	1/20/04	1600	77	< 10	< 10	< 10	<5	<5	<.3
III-GW	1/20/04	1445	92	< 10	< 10	< 10	<5	<5	<.3
IV-A	1/21/04	0845	44	< 10	< 10	< 10	<5	<5	<.3
IV-B	1/21/04	0815	54	< 10	< 10	< 10	<5	<5	<.3
IV-GW	1/21/04	0915	96	< 10	< 10	< 10	<5	<5	<.3
V-A	1/21/04	1115	45	< 10	< 10	< 10	<5	<5	<.3
V-B	1/21/04	1145	44	< 10	< 10	< 10	<5	<5	<.3
V-GW	1/21/04	1230	33	< 10	< 10	99	<5	<5	<.3

Table 20. Inorganic non-metal concentrations in water samples collected from Shenandoah Valley, Va.

[BOD, biologica

TOC, total organic carbon; DOC, dissolved organic carbon; < less than]

Sample identification	Date	Time	BOD, mg/L	Nitrate, mg/L	Nitrite, mg/L	Ammonia, ppm	Ortho-phosphate, ppm	TKN, ppm	COD, mg/L	TOC, mg/L	DOC, mg/L
II-B	1/12/04	1545	2	3.32	0.05	< 0.04	<.02	0.3	<5	2.2	<2
II-GW	1/12/04	1515	<2	13.3	.04	<.04	<.02	<.1	<5	<2	<2
I-A	1/13/04	0900	<2	1.76	.01	<.04	<.02	.2	<5	<2	<2
I-B	1/13/04	0915	<2	5.6	.02	<.04	<.02	.3	<5	<2	<2
I-GW	1/13/04	1030	<2	15.22	<.01	<.04	<.02	.1	<5	<2	<2
III-GW	1/13/04	1345	<2	8.64	<.01	<.04	<.02	.1	<5	<2	<2
VI-A	2/17/04	1353	<2	0.56	<.01	<.04	<.02	.1	<5	<2	<2
VI-B	2/17/04	1312	<2	0.62	<.01	<.04	<.02	.1	<5	<2	<2
VI-GW	2/17/04	1142	<2	11.97	<.01	<.04	<.02	<.1	<5	<2	<2
VI-spring	2/17/04	1223	<2	1.28	<.01	<.04	<.02	<.1	<5	<2	<2
V-A	2/19/04	1228	<2	2.5	<.01	<.04	.02	<.1	<5	<2	<2
V-B	2/19/04	1258	<2	2.53	<.01	<.04	.02	.3	<5	<2	<2
V-GW-new	2/19/04	1102	<2	6.72	.06	<.04	<.02	<.1	<5	<2	<2
V-GW-house	2/19/04	1202	<2	10.02	.26	.12	<.02	<.1	<5	<2	<2
V-GW-silo	2/19/04	1134	<2	12.21	<.01	<.04	<.02	<.1	<5	<2	<2

 Table 21.
 Inorganic non-metal concentrations in water samples collected from Eastern Shore, Va.

[BOD, b

demand; TOC, total organic carbon; DOC, dissolved organic carbon; < less than]

Sample identification	Date	Time	BOD, mg/L	Nitrate, mg/L	Nitrite, mg/L	Ammonia, ppm	Ortho-phosphate, ppm	TKN, ppm	COD, mg/L	TOC, mg/L	DOC, mg/L
II-A	1/20/04	1045	<2	0.69	< 0.01	< 0.04	< 0.02	0.4	12.04	4.8	4.5
II-B	1/20/04	1145	<2	2.06	<.01	<.04	<.02	.5	13.59	5.4	5.4
II-GW	1/20/04	1115	<2	<.04	<.01	.12	<.02	.1	<5	<2	<2
III-A	1/20/04	1530	2	2.6	<.01	.04	<.02	.5	5.66	3.2	3.1
III-B	1/20/04	1600	<2	5	<.01	<.04	<.02	.4	<5	3	2.8
III-GW	1/20/04	1445	<2	<.04	<.01	.16	<.02	.2	<5	<2	<2
IV-A	1/21/04	0845	2	1.7	<.01	.07	<.02	.5	10.64	5.8	5.2
IV-B	1/21/04	815	<2	7.5	<.01	.4	<.02	.6	18.35	6.8	7.6
IV-GW	1/21/04	915	<2	<.04	<.01	.32	.06	.7	<5	<2	<2
V-A	1/21/04	1115	<2	1.3	<.01	.08	<.02	.8	28.07	11.2	10.9
V-B	1/21/04	1145	<2	1.03	<.01	.15	<.02	.2	15.95	7.7	7.4
V-GW	1/21/04	1230	<2	<.04	<.01	.58	.11	1.4	<5	3.7	3.3

**Table 22.** Microbiological results for replicate ground- and surface-water samples collected from Shenandoah Valley, Va.

[Virginia instantaneous water-quality standard for *E. coli* is 235 colony-forming units per 100 milliliters (units/100 mL); for enteroccoci, the standard is 61 colony-forming units/100 mL (9 VAC 25-260-170)]

				oci/100 mL
1 0	10-mL dilu	tion 50-mL dilution	10-mL dilution	50-mL dilution
1 0	G	round Water		
VI-spring replicate 2/17/04 12	23 10	4	<10	2
	28 <10	4	<10	<2
V-GW-new 2/19/04 11	02		<10	6
V-GW-new replicate 2/19/04 11	07		<10	<2
V-GW-house 2/19/04 12	.02	otained because of media	50	<2
V-GW-house replicate 2/19/04 12	confirmed	able colonies picked and	10	<2
V-GW-silo 2/19/04 11	34	us Er con	<10	2
V-GW-silo replicate 2/19/04 11	39		<10	<2

Sample	Data	T:	E. coli	/100 mL	Enterocc	oci/100 mL
identification	Date	Time	5-mL dilution	20-mL dilution	5-mL dilution	20-mL dilution
			Surface V	Vater		
VI-A	2/17/04	1353	<20	<5	<20	<5
VI-A replicate	2/17/04	1358	<20	5	20	55
VI-B	2/17/04	1312	<20	5	<20	<5
VI-B replicate	2/17/04	1317	<20	5	20	10
V-A	2/19/04	1228			20	80
V-A replicate	2/19/04	1233	No counts obtained		40	100
V-B	2/19/04	1258	failure. Viable col		40	65
V-B replicate	2/19/04	1303	commined as E. c		100	35

 Table 23.
 Identification of bacterial isolates for replicate samples collected from Shenandoah Valley, Va.

[a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

Sample	Colony			E. coli	Enterd	cocci	Salmonella spp.	Ca	mpylobacte	er spp.
identification	number	Date	Time	Identification	PYR test	Lap test	Identification	0xidase	Catalase	Gram stain
VI-B	1	2/17/04	1312	E. coli 1–96.5%			Not Salmonella spp. Not Tested			Negative
	2						Not Salmonella spp. Not Tested			
	3						Not Salmonella spp. Not Tested			
	4									
	5									
	6									
	7									
	8									
	9									
	10									
VI-B replicate	1	2/17/04	1317	E. coli 1–96.5%	Positive	Positive	Not Salmonella spp. Not Tested			Negative
	2				Not entero primary		Not Salmonella spp. Not Tested			
	3						Hafnia alvei–99.2%			
	4						Not Salmonella spp. Not Tested			
	5						Not Salmonella spp. Not Tested			
	6						Not Salmonella spp. Not Tested			
	7									
	8									
	9									
	10									
VI-GW	1	2/17/04	1142							
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
VI-GW repli-	10 1	2/17/04	1147							
cate	2									
	2 3									

**Table 23.** Identification of bacterial isolates for replicate samples collected from Shenandoah Valley, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

Sample	Colony	_		E. coli	Enterd	cocci	Salmonella spp.	Са	mpylobacte	
identification	number	Date	Time	Identification	PYR test	Lap test	Identification	Oxidase	Catalase	Gram stain
	4									
	5									
	6									
	7									
	8									
	9									
	10									
VI-spring	1	2/17/04	1223	E. coli 1–96.5%	Positive	Positive	Not Salmonella spp. Not Tested			
	2			E. coli 1–96.5%			Not Salmonella spp. Not Tested			
	3			E. coli 1–96.5%			Not Salmonella spp. Not Tested			
	4						Not Salmonella spp. Not Tested			
	5						Not Salmonella spp. Not Tested			
	6									
	7									
	8									
	9									
	10									
VI-spring replicate	1	2/17/04	1228	E. coli 1–96.5%						
	2			E. coli 1–96.5%						
	3									
	4									
	5									
	6									
	7									
	8 9									
	10									
V-A	1	2/19/04	1228	Not E. coli Not Tested	Positive	Positive	Salmonella spp. –97.5%			Negative
	2			E. coli 1– 99.1%	Negative	Negative	Salmonella spp. –97.5%			
	3				Negative	Negative	Salmonella spp. –97.5%			
	4				Negative	Negative	Salmonella spp. –97.5%			

**Table 23.** Identification of bacterial isolates for replicate samples collected from Shenandoah Valley, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

Sample	Colony	_		E. coli	Enterd	cocci	Salmonella spp.	Са	mpylobacte	er spp.
identification	number	Date	Time	Identification	PYR test	Lap test	Identification	Oxidase	Catalase	Gram stain
	5				Not entero	ococci	Not Salmonella spp. Not Tested			
	6				Not entero	ococci	Salmonella spp. –97.5%			
	7				Not entero	ococci	Salmonella spp. –97.5%			
	8				Not entero	ococci	Salmonella spp. –97.5%			
	9				Not entero	ococci	Salmonella spp. –97.5%			
	10				Not entero	ococci	Salmonella spp. –97.5%			
V-A replicate	1	2/19/04	1233	E. coli 1–96.5%	Negative	Negative	Salmonella spp. –99.9%			Negative
	2			E. coli 1–99.1%	Negative	Negative	Salmonella spp. –99.9%			
	3			E. coli 1–99.1%	Positive	Positive	Salmonella spp. –99.9%			
	4			E. coli 1–96.5%	Negative	Negative	Salmonella spp. –99.9%			
	5				Negative	Negative	Salmonella spp. –99.9%			
	6				Negative	Negative	Salmonella spp. –99.9%			
	7				Negative	Negative	Salmonella spp. –99.9%			
	8				Not entero	ococci	Salmonella spp. –99.9%			
	9				Not entero	ecocci	Salmonella spp. –99.9%			
	10				Negative	Negative	Serratia oderifera 1			
V-B	1	2/19/04	1258	Not E. coli Not Tested	Negative	Negative				Negative
	2			Not E. coli Not Tested	Negative	Negative				
	3			Not E. coli Not Tested	Positive	Positive				
	4			E. coli 1–97.7%	Positive	Positive				
	5				Positive	Positive				
	6				Positive	Positive				
	7				Negative	Negative				
	8				Negative	Negative				
	9				Positive	Negative				
	10				Negative	Negative				
V-B replicate	1	2/19/04	1303		Negative	Negative				Negative
	2				Not entero	cocci				

Table 23. Identification of bacterial isolates for replicate samples collected from Shenandoah Valley, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

Sample	Colony			E. coli	Enterd	cocci	Salmonella spp.	Ca	mpylobacte	rspp.
identification	number	Date	Time	Identification	PYR test	Lap test	Identification	0xidase	Catalase	Gram stain
	3				Not entero	cocci				
	4				Not entero	cocci				
	5				Negative	Negative				
	6				Negative	Negative				
	7				Not entero	cocci				
	8				Not entero	cocci				
	9				Not entero	cocci				
	10				Not entero	cocci				
V-GW-new	1	2/19/04	1102		Negative	Positive				
	2				Positive	Positive				
	3				Positive	Positive				
	4									
	5									
	6									
	7									
	8									
	9									
	10									
V-GW-new replicate	1	2/19/04	1107							
1	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
V-GW-house	1	2/19/04	1202		Negative	Positive				Negative
	2	_,_,,,,,,			NG	NG				
	3				NG	NG				
	4				Not enter					
	5				prima	ary plate				
	5									
	6									
	7									
	8									
	9									
	10									

**Table 23.** Identification of bacterial isolates for replicate samples collected from Shenandoah Valley, Va.—Continued [a blank row indicates that 10 viable colonies were not available to analyze; NG, no growth]

Comula	Calanu			E. coli	Enterd	ococci	Salmonella spp.	Са	mpylobacte	r spp.
Sample identification	Colony number	Date	Time	Identification	PYR test	Lap test	Identification	Oxidase	Catalase	Gram stain
V-GW-house replicate	1	2/19/04	1207		NG	NG				
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
W.C.W. 'I	10	2/10/04	1124		NT - 2	D 11				NT
V-GW-silo	1 2	2/19/04	1134		Negative	Positive				Negative
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
V-GW-silo replicate	1	2/19/04	1139							Negative
	2						Not Salmonella spp.			
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									

 Table 24.
 Antibiotic sensitivities for E. coli for replicate samples collected from Shenandoah Valley, Va.

Sample identification	Colony Number	Date	Time		Amikacın		Certiorur		Gentamicin		Neomyciii		Spectinomycin		streptomycin	Totacator	ieu acyciiie		rimethoprim
identification	ivanibei			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
VI-A	1	2/17/04	1353																
	2																		
	3																		
	4																		
	5																		
	6																		
	7 8																		
	9																		
	10																		
VI-A replicate	1	2/17/04	1358	22	S	25	S	21	S	18	S	23	S	15	S	20	S	30	S
Ţ	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-B	1	2/17/04	1312	23	S	27	S	23	S	17	S	23	S	15	S	15	I	25	S
	2																		
	3																		
	4 5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-B replicate	1	2/17/04	1317	23	S	25	S	23	S	19	S	20	S	16	S	20	S	29	S
	2																		
	3																		
	4																		
	5																		

**Table 24.** Antibiotic sensitivities for *E. coli* for replicate samples collected from Shenandoah Valley, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony Number	Date	Time	Amilyooin	Allilkaciii	, define				Moomio	Meoninyciii		Specimomycin		orrepromyciii	Tetracycline	ieu acy ciiile	F	Trimethoprim
identification	itamboi			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	6																		
	7																		
	8																		
	9																		
VII CIV	10	2/17/04	1110																
VI-GW	1	2/17/04	1142																
	2 3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-GW replicate	1	2/17/04	1147																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-spring	1	2/17/04	1223		S	27	S	23	S	19			S	15	S	22	S	29	
	2				S	27	S	22	S	19			S	16	S	20		25	
	3			20	S	25	S	21	S	18	S	21	S	14	Ι	19	S	25	S
	4																		
	5 6																		
	7																		
	8																		
	9																		
	10																		

60

**Table 24.** Antibiotic sensitivities for *E. coli* for replicate samples collected from Shenandoah Valley, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony Number	Date	Time		Amikacin	, teriofin	reinoini		Gentamicin		Meomyciii		Spectinomycin		Streptomycin	Totroconlino	ieu acy cillie		rimetnoprim
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
VI-spring replicate	1	2/17/04	1228	22	S	26	S	22	S	20	S	23	S	14	I	20	S	26	S
	2			22	S	27	S	22	S	19	S	24	S	14	I	20	S	27	S
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-A	1	2/19/04	1228																
	2			20	S	26	S	21	S	19	S	22	S	15	S	19	S	26	S
	3																		
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	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-A replicate	1	2/19/04	1233	24	S	28	S	22	S	20	S	23	S	16	S	21	S	26	S
	2			23	S	26	S	22	S	18	S	23	S	15	S	20	S	26	S
	3			21	S	23	S	19	S	17	S	20	S	15	S	19	S	26	S
	4			22	S	28	S	22	S	18	S	22	S	15	S	21	S	28	S
	5																		
	6 7																		
	8																		
	8 9																		
	10																		
V-B	10	2/19/04	1258																
τ υ	2	41171U <del>1</del>	1230																
	3																		
	4			22	S	25	S	10	R	20	S	13	ī	7.5	R	7.5	R	26	S
	+			44	S	23	S	10	1	20	S	13	1	1.5	1/	1.5	1	20	S

**Table 24.** Antibiotic sensitivities for *E. coli* for replicate samples collected from Shenandoah Valley, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony Number	Date	Time		Amikacın	34.5	Centionar		Gentamicin	Noomoin	Neomyciii		Spectinomycin		Streptomycin	T. (1.00.1)	letracycline		Irimethoprim
	- Tumbo			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-B replicate	1	2/19/04	1303																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10	2410104	1100																
V-GW-new	1	2/19/04	1102																
	2																		
	3																		
	4 5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-GW-new replicate	1	2/19/04	1107																
	2	_, _,, , ,																	
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		

Table 24. Antibiotic sensitivities for *E. coli* for replicate samples collected from Shenandoah Valley, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony Number	Date	Time	Amikacin	3	Септотиг		Gentamicin	Noomycin			Spectinomycin	·	streptomycin	Total	leuacycime	1,000	пттетпортт
identification	Number			Zone size Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	10																	
V-GW-house	1	2/19/04	1202															
	2																	
	3																	
	4																	
	5																	
	6																	
	7																	
	8																	
	9																	
	10																	
V-GW-house replicate	1	2/19/04	1207															
	2																	
	3																	
	4																	
	5																	
	6																	
	7																	
	8																	
	9																	
	10																	
V-GW-silo	1	2/19/04	1134															
	2																	
	3																	
	4																	
	5																	
	6																	
	7																	
	8 9																	
V-GW-silo replicate	10 1	2/19/04	1139															
v-G w-sno replicate	2	4/19/04	1139															
	3																	
	4																	

**Table 24.** Antibiotic sensitivities for *E. coli* for replicate samples collected from Shenandoah Valley, Va.—Continued [Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze]

Sample identification	Colony Number	Date	Time	Amilyonia	AIIIIKaciii				Gentamicin	Noomioin	Meoniny cill		Specunomycin		streptomycin	Totto	alliacy cillia		rimethoprim
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		

Table 25. Antibiotic sensitivities for enterococci for replicate samples collected from Shenandoah Valley, Va.

	colonies were not available to analyze]
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	ate;
5	edi
2	tern
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	nt; I
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2	χ. Ά,
-	ters
2	ime
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	Iven
3	að
	disc zone size
2	one
-	SC Z
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	ıntil
•	Ā

	Trimethoprim	əbinə												S												
	misnottomisT	əsis ənoS												29												
	nisosimliT	əbiuə												S												
	misseim!iT	əsis ənoS												15												
	Tetracycline	əbinə												S												
	onilovesteT	əsis ənoS												19												
	Streptomycin	əbiuə												R												
	niavmotnest2	əsis ənoS												7.5												
	Spectinomyci	əbiuə												S												
l ui	iovmonitaen2	əsis ənoS												18												
		əbiuə												S												
	Penicillin	əsis ənoS												16												
		əbiuə												×												
	Иеотусіп	əsis ənoS												11												
		əbiuə												×												
	nioimatnað	əsis ənoS												12												
		əbiuə												×												
	Clindamycin	əsis ənoS												7.5												
		əbinə												$\simeq$												
	Ceftiofur	əsis ənoS												7.5												
		əbinə												Ι												
	Bacitracin	əsis ənoS												12												
		əbinə												×												
	Amikacin	əsis ənoS												6												
	Time		1353										1358										1312			
	F		13										13										13			
	Date		2/17/04										2/17/04										2/17/04			
	۵		2/1										2/1										2/1			
	Colony		_	2	3	4	2	9	7	∞	6	10	_	2	3	4	2	9	7	∞	6	10	-	2	3	4
	S																									
	=																									
	Sample identification												ate													
	Sample entificati												replic													
	.9		VI-A										VI-A replicate										VI-B			
			-										_													

[Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze] Table 25. Antibiotic sensitivities for enterococci for replicate samples collected from Shenandoah Valley, Va.—Continued

- 1			I																							
	e mirqodtəmirT	əbinə							S																	
		əsis ənoS							25																	
	Tilmicosin	əbinə							Ι																	
		əsis ənoS							11																	
	Tetracycline	əbinə							S																	
		əsis ənoS							20																	
	Streptomycin	əbiuƏ							R																	
	-,,,-	əsis ənoS							7.5																	
	Spectinomycin	əbiuə							Ι																	
ui	aiovenonitoon2	əsis ənoS							12																	
	IIIII AIII A	əbinə							S																	
	Penicillin	əsis ənoS							19																	
	uu o buu o o su	əbiuə							×																	
	Иеотусіп	əsis ənoS							12																	
	шашти	əbiuə							×																	
	Gentamicin	əsis ənoS							12																	
	Clindamycin	əbiuə							×																	
	niavmshnila	əsis ənoS							7.5																	
		əbinə							×																	
	Ceftiofur	əsis ənoS							6																	
		əbinə							S																	
	Bacitracin	əsis ənoS							13																	
		əbinə							×																	
	Amikacin	əsis ənoS							7.5																	
	Time								1317									11.45	7							
	F								13									=	7							
	Date								2/17/04									7/17/04	40/11/2							
	Colony		5	9	7	∞	6	10	1	2	3	4	5	9	7	∞	6	10	-	7	3	4	5	9	7	∞
	Sample								VI-B replicate									VI CW	*D-1							

[Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze] Table 25. Antibiotic sensitivities for enterococci for replicate samples collected from Shenandoah Valley, Va.—Continued

Streptomycin  Streptomycin  Tetracycline  Tilmicosin	əbinə əsis ənoS													S 7.5 R 21 S 14 S 30 S										
nillioina9	əsis ənoS əbiuə əsis ənoS													25 S 16										
Иеотусіп	əbinə əsis ənoS əbinə													I 11 R										
Clindamycin Gentamicin	əbinə əsis ənoZ													R 14										
Turioitie	ebinə əbinə əzis ənoZ													21 S 7.5										
Bacitracin	əsis ənoS əbinə													8 R										
Атікасіп	əsis ənoS əbiuƏ													15 I										
Тше				1147										1223										
Date				2/17/04										2/17/04										
Colony		6	10	1	2	3	4	5	9	7	∞	6	10	1	2	3	4	5	9	7	∞	6	-	10
Sample				VI-GW replicate										VI-spring										

[Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze] Table 25. Antibiotic sensitivities for enterococci for replicate samples collected from Shenandoah Valley, Va.—Continued

inandtomit	əzis ənoZ										22												. 27	
Tilmicosim																								
Tetracycline	əbinə										R													
	əsis ənoS										7.5												19	
Ztreptomycın	əbinə										R												R	
	əsis ənoS										7.5												7.5	
рвеспиошуся	əbinə										Ι												Ι	
3	əsis ənoS										13												13	
remenin	əbinə										S												S	
":II:•:u-d	əsis ənoS										18												18	
шалшлам	əbinə										Ι												R	
aiovmoold	əsis ənoS										16												12	
מפוונפוווניווו	əbinə										×												Ι	
nioimetaog	əsis ənoS										7.5												13	
uu akuupauu a	əbiuə										×												R	
niovmehail	əsis ənoS										7.5												13	
monio	əbinə										2												R	
Cottintur	əsis ənoS										7.5												10	
on niona	əbinə										×												S	
niaertiae8	əsis ənoS										7.5												13	
	əbinə										×												R	
Amikacin	əsis ənoS										13												10	
T me											1228										1233			
Date											2/19/04										2/19/04			
Colony		2	3	4	5	9	7	∞	6	10	1	2	33	4	2	9	7	∞	6	10	1	2	8	4
Sample											V-A										V-A replicate			
	Colony  Amikacin Bacitracin Ceftiofur Clindamycin Gentamicin Meomycin Streptomycin Streptomycin	Zone size Guide Cuide	Tame size  Cone size  Cuide  C	Colony Size Suide  Cone size  Cuide  Cuide	Cone size  Cuide C	Cone size  Cuide C	Tone size  Cone size	Zone size  Date de Guide  Cuide  Cuide  Cuide  Cuide  Cuide  Cuide  Cuide  Cuide  Contamycin  Cuide  Cuide  Contamicin  Cuide  Contamicin  Cuide  Contamicin  Cuide  Contamycin  Contamycin  Cuide  Contamycin  Contamycin	Colony de la companyoin a la c	Golony  Timple  Timple	Timicosin  Cone size  Contide  Contide  Conde  Conde  Contide  Contide  Conde  Conde	Colony  Table  Coulde  Coulde	Sample Colony  Amikacin Immber Time  Guide  Connesize  Connesize	Sample Golony  Guide  Cone size  Contine  Cone size  Contine  Cone size  Cone size  Contine  Cone size  Cone s	Asimple dentification number dentification number dentification number dentification number dentification number dentification number dentification dentification dentification dentification number dentified dentification dentified dentification dentified d	Sample Golony  Time by Markerin    Amikacin    Amikacin    Cettiodury    Cettiodury	Sample d'entification multiple d'entification d'entification d'entification multiple d'entification multiple d'entification multiple d'entification d'entifi	Sample of Colony Interception and the colony of the colon of th	Sample of Colony and Marketin a	Sample de Gentinerien de Lolony de Sire de Colon	Amikacin  Tame  Ta	Color   Colo	Sample   Color   Color	Sample (and in the first state of the first state o

[Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze] Table 25. Antibiotic sensitivities for enterococci for replicate samples collected from Shenandoah Valley, Va.—Continued

	_	əbinə									S	S	S	S											
u	Trimethoprin	əzis ənoZ									30	33	30	33											
		əbinə									×	2	R	П											
	Tilmicosin	əzis ənoZ									10	10	7.5	11											
		əbinə									R	R	R	×											
•	Tetracycline	əsis ənoS									7.5	7.5	7.5	7.5											
		əbiuə									R	R	R	×											
u,	Streptomyci	əsis ənoS									7.5	7.5	7.5	7.5											
		əbinə									R	R	S	R											
nio	Spectinomy	əsis ənoS									7.5	7.5	16	7.5											
		əbinə									R	R	R	×											
	Penicillin	əsis ənoS									7.5	7.5	7.5	7.5											
	пісутоэМ	əbinə									R	ĸ	R	S											
	niavmoeM	əsis ənoS									7.5	7.5	7.5	18											
	nioimatnað	əbinə									R	R	Ι	R											
	nioimetaog	əsis ənoS									7.5	7.5	13	7.5											
١.	Clindamycin	əbinə									R	$\simeq$	$\aleph$	$\simeq$											
'	aiovenobail0	əsis ənoS									7.5	7.5	7.5	7.5											
	rułoitłəD	əbinə									R	$\aleph$	R	ĸ											
	*!!}o!#JoJ	əsis ənoS									7.5	7.5	7.5	7.5											
	Bacitracin	əbinə									R	$\aleph$	R	$\aleph$											
	nioontioo d	əsis ənoS									7.5	7.5	7.5	7.5											
	Amikacin	əbinə									R	$\simeq$	$\aleph$	$\simeq$											
	aiocilimA	əsis ənoS									7.5	7.5	11	10											
	Time								1258										1303						
	Date								2/19/04										2/19/04						
	Colony		5	9	7	∞	6	10	1	2	3	4	5	9	7	∞	6	10	1	2	3	4	5	9	7
	Sample identification								V-B										V-B replicate						

[Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze] Table 25. Antibiotic sensitivities for enterococci for replicate samples collected from Shenandoah Valley, Va.—Continued

minqodtəminT	əbinə					S	S																	
TrinnottomisT	əsis ənoS					24	23																	
nisooimlīT	əbiuə					Ι	Ι																	
aisseim!IT	əsis ənoS					12	12																	
Tetracycline	əbinə					S	S																	
ogilovocatoT	əsis ənoS					20	20																	
Streptomycin	əbinə					×	×																	
aiovraotaost2	əsis ənoS					7.5	7.5																	
Spectinomycin	əbinə					Ι	Ι																	
aioumonitoon?	əsis ənoS					12	11																	
Lemenni	əbinə					S	S																	
Penicillin	əsis ənoS					23	22																	
Иеотусіп	əbinə					Ι	Ι																	
aionaooN	əsis ənoS					15	16																	
nioimatneð	əbinə					S	Ι																	
	əsis ənoS					15	13																	
Clindamycin	əbinə					R	R																	
.:	əsis ənoS					7.5	7.5																	
rutoitteO	əbinə					R	R																	
	əsis ənoS					12	7.5																	
nioertioe8	əbinə					Τ	Τ																	
	əsis ənoS					11	12																	
Amikacin	əbinə					R	R																	
	əsis ənoS					13	13																	
Time					1102										1107									
Date					2/19/04										2/19/04									
Colony		∞	6	10	1	2	3	4	5	9	7	∞	6	10	1	2	3	4	5	9	7	∞	6	10
Sample					V-GW-new										V-GW-new replicate									
					>										>									

[Antibiotic disc zone size given in millimeters; R, resistant; I, intermediate; S, susceptible; a blank row indicates that 10 viable colonies were not available to analyze] Table 25. Antibiotic sensitivities for enterococci for replicate samples collected from Shenandoah Valley, Va.—Continued

	Sample identification		V-GW-house										V-GW-house replicate										V-GW-silo		
	Colony		1	2	8	4	5	9	7	∞	6	10	1	7	m ·	4	5	9	7	8	6	10	1	2	3
	Date		2/19/04										2/19/04										2/19/04		
	Time		1202										1207										1134		
	Атікасіп	əsis ənoS əbiuƏ																							
	Bacitracin	əsis ənoS																							
	anniana	əbinə																							
	Ceftiofur	əsis ənoS																							
		abina 																							
	Clindamycin	esis enos																							
		əbinə əzis ənoZ																							
	nioimatnað	əbinə																							
	Иеотусіп	əsis ənoS																							
	o.koosi	əbinə																							
	Penicillin	əzis ənoZ																							
		əbinə																							
	Spectinomycin	ezis enoZ ebiuð																							
		əzis ənoZ																							
	Streptomycin	əbinə																							
	Tetracycline	əzis ənoZ																							
	auu o f on u o a	əbinə																							
	Tilmicosin	əsis ənoS																							
		ebin 9																							
	Trimethoprim	əsis ənoS əbinə																							
1		anıno	l																						

Table 25. Antibiotic sensitivities for enterococci for replicate samples collected from Shenandoah Valley, Va.—Continued

ı		I																1
Trimethoprim	əbinə																	
	əzis ənoZ																	
Tilmicosin	esis enos ebiuð																	
Tetracycline	əbinə																	
	əzis ənoZ																	
Streptomycin	əbinə																	
	əsis ənoS																	
Spectinomycin	əbinə																	
	əsis ənoS																	
Penicillin	əbinə																	
	əsis ənoS																	
Иеотусіп	əbinƏ																	
	əsis ənoS																	
nioimatnað	əbinƏ																	
	əsis ənoS																	
Clindamycin	əbinə																	
	əsis ənoS																	
Ceftiofur	əbinə																	
7.70	əsis ənoS																	
Racitracin	əbinə																	
	əsis ənoS																	
Amikacin	əbiuə																	
niocyim	əsis ənoS																	
Time									1139									
F									Ξ									
Date									2/19/04									
õ									2/1									
Colony			10		4	~	6	10		63	~		2	9	7	∞	6	10
Col		4	4,	v	(-	∞	0,	ī	_	2	3	4	α,	9	(-	000	5	_
									te									
le ation									plica									
Sample identification									ilo re									
ider ider									V-GW-silo replicate									
									>									

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**Table 26.** Antibiotic sensitivities for *Salmonella* spp. for replicate samples collected from Shenandoah Valley, Va.

Sample identification	Colony number	Date	Time		Amikacin	Cofficence			Gentamicin		Neomyciii		Specunomycin	Otto a to	ou epromyciii	Totto	ieudcyciiile	Trimethonrim	
iucillinoution	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
VI-A	1	2/17/04	1353																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-A replicate	1	2/17/04	1358																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-B	1	2/17/04	1312																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-B replicate	1	2/17/04	1317																
	2																		
	3																		
	4																		
	5																		
	6																		

**Table 26.** Antibiotic sensitivities for *Salmonella* spp. for replicate samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time		AIIIIKaciii	, inde			Gentamicin		Neomycin	Crootingminin	Specimonycin	Ctrontomic.	anepromyciii	:	Tetracycline		ігіметпоргіш
				Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	7																		
	8																		
	9																		
	10																		
VI-GW	1	2/17/04	1142																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-GW replicate	1	2/17/04	1147																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-spring	1	2/17/04	1223																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
VI-spring replicate	1	2/17/04	1228																
	2																		

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**Table 26.** Antibiotic sensitivities for *Salmonella* spp. for replicate samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time		AIIIIKACIII	Cofficient				Noomioin		Cnootinomioin	opecunomyciii	Othor to motor of the	ouepromyciii	7.10.00	letracycille		rimethoprim
identification	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-A	1	2/19/04	1228	22	S	21	S	21	S	18	S	20	S	13	I	19	S	22	S
	2			21	S	24	S	21	S	19	S	17	S	12	I	18	I	22	S
	3			21	S	24	S	19	S	18	S	17	S	12	I	19	S	21	S
	4			22	S	22	S	19	S	19	S	18	S	12	I	18	I	20	S
	5																		
	6			22	S	22	S	19	S	18	S	18	S	12	I	19	S	20	S
	7			21	S	22	S	20	S	18	S	18	S	11	R	18	I	22	S
	8			22	S	23	S	20	S	19	S	17	S	12	Ι	20	S	22	S
	9			21	S	23	S	21	S	20	S	17	S	11	R	18	I	21	S
	10			21	S	23	S	20	S	18	S	18	S	11	R	18	I	21	S
V-A replicate	1	2/19/04	1333	20	S	23	S	20	S	19	S	19	S	12	I	12	R	22	S
	2			22	S	26	S	19	S	19	S	22	S	13	I	20	S	24	S
	3			22	S	24	S	20	S	20	S	20	S	14	I	16	I	26	S
	4			21	S	24	S	21	S	19	S	19	S	13	I	21	S	26	S
	5			22	S	23	S	22	S	19	S	19	S	13	Ι	19	S	26	S
	6			22	S	25	S	20	S	20	S	20	S	13	Ι	20	S	25	S
	7			21	S	26	S	21	S	20	S	21	S	14	I	16	I	25	S
	8			20	S	24	S	22	S	19	S	19	S	13	Ι	10	R	25	S
	9			22	S	24	S	21	S		S		S				I	26	
	10																		
V-B	1	2/19/04	1258																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		

**Table 26**. Antibiotic sensitivities for *Salmonella* spp. for replicate samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time		Ашкасіп	Ceftiofur		Contomioin	Gentamicin		Neomycin		Specunomycin	Ct. Compton	ouepromyciii	:	Tetracycline		rimethoprim
iuenuncauon	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	9				_		_		_		_		_		_				
	10																		
V-B replicate	1	2/19/04	1303																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-GW-new	1	2/19/04	1102																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-GW-new replicate	1	2/19/04	1107																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-GW-house	1	2/19/04	1202																
	2																		
	3																		
	4																		

Table 26. Antibiotic sensitivities for Salmonella spp. for replicate samples collected from Shenandoah Valley, Va.—Continued

Sample identification	Colony number	Date	Time		Amikacin	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		Contomicin			меошусп	: ;;;;;	эресплотуст		Streptonnycin		letracycline	4000	ırımemoprım
idoninioanon	number			Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide	Zone size	Guide
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-GW-house replicate	1	2/19/04	1207																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-GW-silo	1	2/19/04	1134																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		
V-GW-silo replicate	1	2/19/04	1139																
	2																		
	3																		
	4																		
	5																		
	6																		
	7																		
	8																		
	9																		
	10																		

 Table 27.
 Metal concentrations in replicate samples collected from Shenandoah Valley, Va.

[ ppm, parts per million;  $\mu g/L$ , micrograms per liter; < less than]

Sample identification	Date	Time	Hardness, ppm	Chromium, µg/L	Nickel, μg/L	Copper, µg/L	Arsenic, µg/L	Cadmium, µg/L	Mercury, μg/L
VI-A	2/17/04	1353	49	< 10	< 10	< 10	<5	<5	<0.3
VI-A replicate	2/17/04	1358	49	< 10	< 10	< 10	<5	<5	<.3
VI-B	2/17/04	1312	56	< 10	< 10	< 10	<5	<5	<.3
VI-B replicate	2/17/04	1317	55	< 10	< 10	< 10	<5	<5	<.3
VI-GW	2/17/04	1142	519	< 10	< 10	< 10	<5	<5	<.3
VI-GW replicate	2/17/04	1147	505	< 10	< 10	< 10	<5	<5	<.3
VI-spring	2/17/04	1223	275	< 10	< 10	< 10	<5	<5	<.3
VI-spring replicate	2/17/04	1228	286	< 10	< 10	< 10	<5	<5	<.3
V-A	2/19/04	1228	158	< 10	< 10	< 10	<5	<5	<.3
V-A replicate	2/19/04	1233	153	< 10	< 10	< 10	<5	<5	<.3
V-B	2/19/04	1258	136	< 10	< 10	< 10	<5	<5	<.3
V-B replicate	2/19/04	1303	140	< 10	< 10	< 10	<5	<5	<.3
V-GW-new	2/19/04	1102	6	< 10	< 10	11	<5	<5	<.3
V-GW-new replicate	2/19/04	1107	6	< 10	< 10	11	<5	<5	<.3
V-GW-house	2/19/04	1202	329	< 10	< 10	47.3	<5	<5	<.3
V-GW-house replicate	2/19/04	1207	340	< 10	< 10	88.9	<5	<5	<.3
V-GW-silo	2/19/04	1134	371	< 10	< 10	36.8	<5	<5	<.3
V-GW-silo replicate	2/19/04	1139	379	< 10	< 10	21.3	<5	<5	<.3

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 $\textbf{Table 28.} \quad \text{Inorganic non-metal concentrations in replicate samples collected from Shenandoah Valley, Va.} \\$ 

demand; TOC, total organic carbon; DOC, dissolved organic carbon; < less than]

Sample identification	Date	Time	BOD, mg/L	Nitrate, mg/L	Nitrite, mg/L	Ammonia, ppm	Ortho-phosphate, ppm	TKN, ppm	COD, mg/L	TOC, mg/L	DOC, mg/L
VI-A	2/17/04	1353	<2	0.56	< 0.01	< 0.04	< 0.02	0.1	<5	<2	<2
VI-A replicate	2/17/04	1358	<2	.56	<.01	<.04	<.02	<.1	<5	<2	<2
VI-B	2/17/04	1312	<2	.62	<.01	<.04	<.02	.1	<5	<2	<2
VI-B replicate	2/17/04	1317	<2	.61	<.01	<.04	<.02	.1	<5	<2	<2
VI-GW	2/17/04	1142	<2	11.97	<.01	<.04	<.02	<.1	<5	<2	<2
VI-GW replicate	2/17/04	1147	<2	12.03	<.01	<.04	<.02	<.1	<5	<2	<2
VI-spring	2/17/04	1223	<2	1.28	<.01	<.04	<.02	<.1	<5	<2	<2
VI-spring replicate	2/17/04	1228	<2	1.08	<.01	<.04	<.02	<.1	<5	<2	<2
V-A	2/19/04	1228	<2	2.5	<.01	<.04	.02	<.1	<5	<2	<2
V-A replicate	2/19/04	1233	<2	2.35	<.01	<.04	.02	.1	<5	<2	<2
V-B	2/19/04	1258	<2	2.53	<.01	<.04	.02	.3	<5	<2	<2
V-B replicate	2/19/04	1303	<2	2.32	<.01	<.04	.02	.1	<5	<2	<2
V-GW-new	2/19/04	1102	<2	6.72	.06	<.04	<.02	<.1	<5	<2	<2
V-GW-new replicate	2/19/04	1107	<2	6.75	.06	<.04	<.02	.1	<5	<2	<2
V-GW-house	2/19/04	1202	<2	10.02	.26	.12	<.02	<.1	<5	<2	<2
V-GW-house replicate	2/19/04	1207	<2	10.01	.26	.12	<.02	<.1	<5	<2	<2
V-GW-silo	2/19/04	1134	<2	12.21	<.01	<.04	<.02	<.1	<5	<2	<2
V-GW-silo replicate	2/19/04	1139	<2	12.26	<.01	<.04	<.02	<.1	<5	<2	<2